Engineering News

VOLUME 71 JANUARY 15, 1914 NUMBER 3

The Fontpédrouse Viaduct

A masonry viaduct of exceptionally attractive appearance and somewhat peculiar design is shown in the accompanying view. It is on the line of the Villefranche Bourg-Madame electric railway which connects the two cities of those names in the Pyrenees mountain district of France. The bridge is over the Fontpédrouse gorge through which runs the Le Tet River and one of the French national roads. The electric railway which is carried on the upper level of the viaduct is a meter-gage high-speed line running through hitherto inaccessible districts. It has been under contemplation a long while, but was not completed until 1911. The bridge shown in the view is sometimes known as the Fontpédrouse Viaduct, but more generally as the Séjourné bridge, after the famous French engineer who superintended its design and construction.

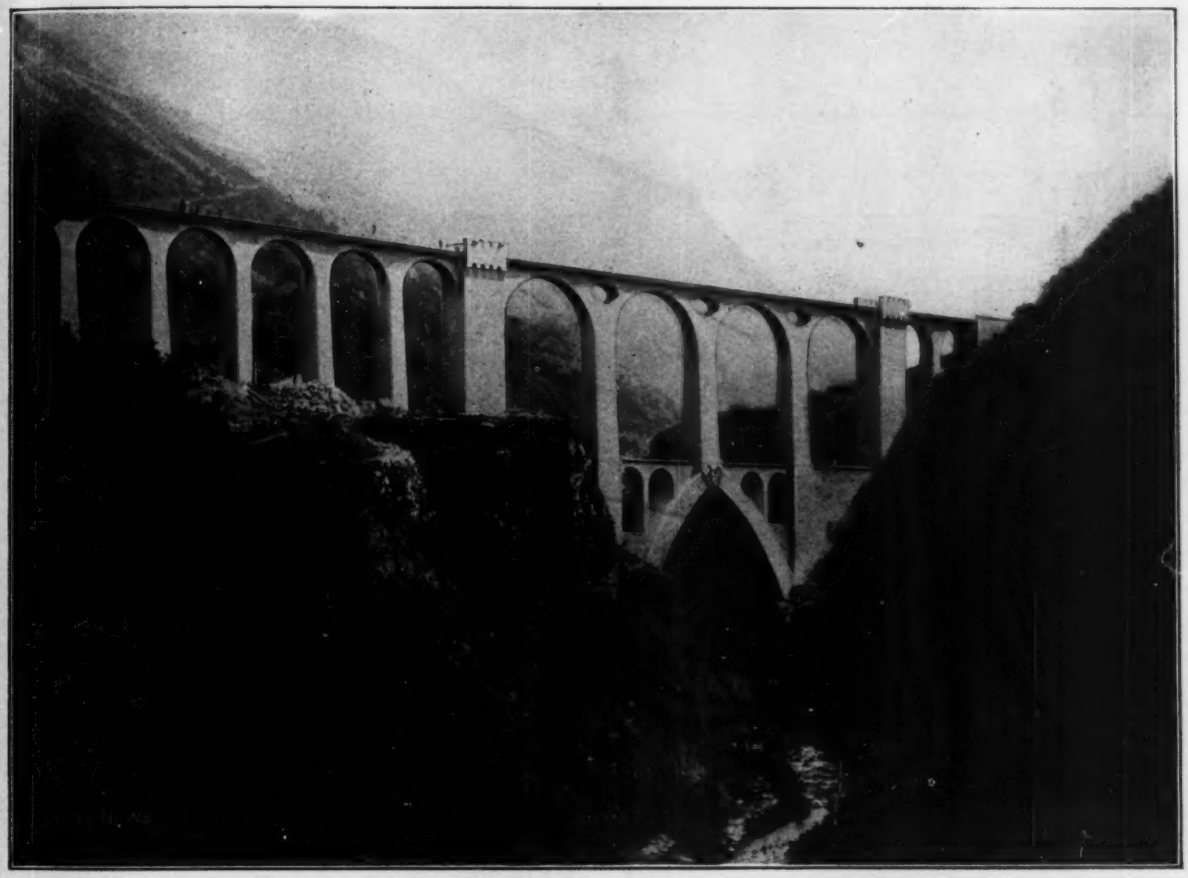

FIG. 1. THE FONTPÉDROUSE VIADUCT IN SOUTHWESTERN FRANCE

The Séjourné bridge is a masonry structure 775 ft. long with an elevation of rail about 214 ft. above the water level of the river. It is made up of approach viaducts on either side, the one toward Bourg-Madame, comprising ten 29½-ft. arches, and the one toward Villefranche, two arches of similar span; the main section of the viaduct is comprised of four full-centered arches, each 56 ft. in span, resting on high, slender piers. The outer two of these piers form heavy pylons which act as the end abutments to the viaduct arch approaches. The next two interior piers reach down to the rock slope of the gorge, and the middle pier rests on a gothic arch which carries the load to the walls of the gorge.

A pronounced differentiation is made between the upper part of the viaduct and the lower supporting arch. This is carried out by contrasting the masonry in the two sections and by providing a pronounced line above the crown of the gothic arch. This line is parallel to the roadway of the viaduct, which is on a 6% grade, and constitutes a walk, supported over the arch by small spandrel arches and beyond the piers by a masonry wall carrying fill.

The main parts of the viaduct are of granite masonry, but the roadway is of a peculiar reinforced-concrete design, which has been applied by Mr. Séjourné to several arch bridges which he has designed. Fig. 2 shows a section through the roadway and the detail of this reinforced-concrete construction. The arches of the viaduct are only 8.2 ft. wide, and at their top elevation they are depressed in the middle so as to leave walls on either side each 2.62 ft. thick, and an interior depression 2.95 ft. wide. Across the top of the walls then are placed reinforced-concrete beams spaced 3.3 ft. c. to c., continuous over the masonry and long enough to overhang about 3 ft. on each side. These beams rest in transverse notches left in the masonry and are provided with small extensions in the lower plane which fit into depressions in the masonry of the arch, so as to hold the roadway against side slipping.

The beams which were cast on the ground and placed as separate and integral members, are reinforced with straight rods, the latter extending up above the upper surface where they are later bonded into the floor slabs. The beams are also provided with spiral reinforcing in the lower or compression plane to increase the compressive value of the concrete there.

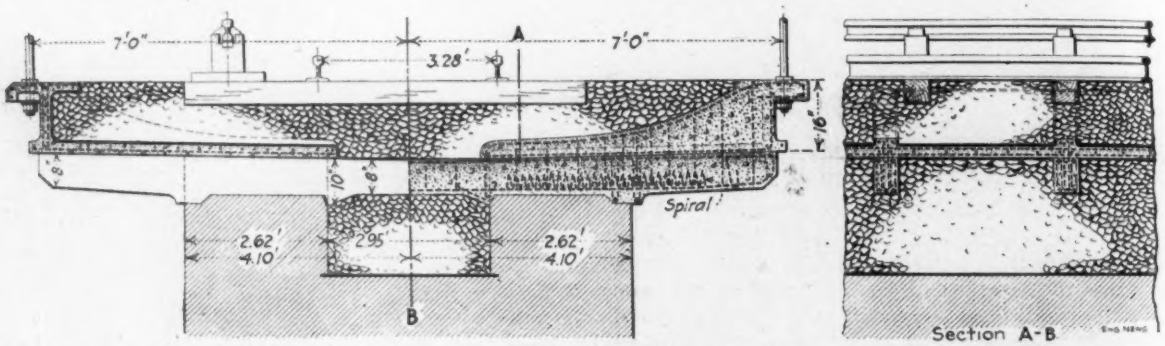

FIG. 2. SECTION THROUGH FLOOR SYSTEM OF FONTPEDROUSE VIADUCT, SHOWING CONCRETE FLOOR ON STONE MASONRY ARCH

After the beams were placed and bonded to the masonry by a mortar joint, a reinforced-concrete slab of the general section shown to the left in Fig. 2, was laid on forms as a continuous floor. This slab has at the same intervals as the supporting beams some buttresses which serve to increase its strength against side pressure. It will be seen that this construction forms a trough 14 ft. wide into which the ballast may be filled and on which the meter-gage track is laid. The upper part of the masonry, as well as the concrete-floor system, is tied together across the entire length of the viaduct to resist any temperature variation.

The supporting gothic arch over the river has a span of 91.5 ft.; its arch rib has a thickness normal to the intrados of 11.5 ft. at the springing line and 8.2 ft. at the crown. In plan it increases in width from the crown to the springing line in an easy curve, so as to give a greater stability. The arch was built on wooden centers making a triangular open section under the arch and braced against the walls of the gorge.

The viaduct is built of local granite, a very beautiful stone easily procured in the neighborhood. This is laid up in lime mortar for the most part, but in cement mortar for the arch ribs. The total cost is given as $110,800, which is about $10 per sq.ft. of roadway surface. This high cost is, of course, due to the isolated location and to the height of the structure.

Blast-Furnace Slag as a Foundation for Paved Streets

By Harvey F. Brown*

Having searched for information on slag as a foundation for brick and block pavements, and found very little material, the author has deemed it worth while to give his observations in regard to this use of slag. Baker, in his "Roads and Pavements," devotes less than ten lines to slag for roads and does not mention it as a foundation material. His last paragraph is: "Slag is used for road purposes only to a limited extent and only near steel mills." This may be true, but our many mills and the low cost of the material make this worthy of some consideration.

The author was called to succeed a borough engineer in a place where three contracts had already been let for paving streets with slag foundations. This is in the Pittsburgh steel district, where slag is quickly and cheaply obtained. It was found there were at least four kinds of slag in use, but the specifications used only the word "slag."

Slag, in general, is the refuse from the blast furnace and is composed of limestone and the impurities of the iron ore, fused together into one homogeneous mass. *Bank slag* is the rough product from the furnace as it has been deposited at the slag bank, and may be of any size or shape. *Crushed slag* may be had of any size and is the bank slag crushed, screened and graded to any particular size. *Screenings* is the residue from the crushed slag passing through a ½-in. screen. It resembles in appearance and composition the limestone screenings used as the top course in macadam roads. *Granulated slag* is the modern product of the blast furnace. It is of a light, porous, sandy nature, and is obtained by pouring the molten slag into water.

The three first named slags can be very easily combined in a strong compact foundation, very much after the manner of a macadam road. But counting the cost of preparation, the limited distribution and the original cost of the material it is doubtful if either of these will ever be used to any extent, although their cementing

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properties make them much superior to the ordinary gravel or broken-stone foundation.

Some engineers maintain that it is impossible to obtain a smooth paved surface upon a slag foundation, but the failure has been due to improper construction more than to the materials. The great trouble has arisen from depressions of varying size appearing in the paved surface, due in all cases to the fact that the foundation materials have not been properly graded and compacted before placing the cushion layer of sand. Thus the sand has gradually worked into the voids of the foundation, causing a slight depression in the street.

Since observing the above fact, the author has obtained a smooth surface by a careful selection and placing of the slag in the foundation courses. Ordinary bank slag was used, with a top coat of screenings, and then rolled by a 10-ton tandem roller to a compacted thickness averaging 7 in. As the slag was brought on the street, laborers with sledges broke all large pieces, while other laborers placed the slag in a layer of proper thickness, being careful to place all large pieces in the bottom and the smaller ones on top.

BLOCKS OF GRANULATED SLAG EXCAVATED FROM A STREET FOUNDATION

(The material was laid in a loose condition, like that shown in the pile in the foreground, and was compacted and cemented under the action of traffic.)

On this was placed a generous layer of screenings. The whole was then thoroughly rolled until no visible voids remained. The slag, because of its keen edges, takes more rolling to compact it than is required for broken stone or gravel. Owing to the labor required in placing and breaking, and the cost of the screenings, this one street cost almost as much as a broken-stone or gravel foundation would have cost. However, the author firmly believes that the use of granulated slag as the foundation material is the solution of a cheap and durable paved street, especially in a locality within reach of the low freight rates of the steel mills. At the present time the contractor can obtain granulated slag for a very small cost, plus the freight, and in some cases the freight is the only cost.

Railways have discovered that fills of granulated slag settle less and become more compact than other material. For this reason in certain portions of the country they have agreed to remove all the slag output of the blast furnaces. With the increase in output the railways are overstocked and are often glad of a place to dispose of it for the cost of transportation. The slight settlement and the tendency to cement under pressure are the chief factors in granulated slag's fitness for a foundation material.

Engineers, chemists and others connected with the manufacture or disposition of slag differ in their opinion of granulated slag as a foundation material. One in particular says "from the very nature of the material it is not suited for this [foundation] purpose."

The accompanying cut tells a different story. The pieces of granulated slag there shown were picked off the surface of an approach to a bridge, from that portion of the roadway which was most traveled and therefore most compacted. The piece on top of the pile is approximately 6x10 in. and was used as a pivot in turning a sandstone curb through an angle of 180°. The stone was 6x24 in., 6 ft. long. Neither the weight nor the twisting had any effect on the slag block. The slag in this road had been in place about 15 months and when placed was as loose as that seen in the small pile in front. It is possible that the continued grinding of the wagon wheels in this case produced some slag powder which assisted the cementing action of the material.

The author has used granulated slag for the foundation of paved streets and has found that thorough rolling under a heavy roller will make a dense foundation, especially if water is used. Such foundations in use for four or five years are so well cemented that it is difficult to break through them in repairing water and gas mains. It is noteworthy that on a recent slip and settlement of a new pavement, due to continued high water, the portion remaining intact was on a granulated slag fill. It has often been noted that cuts in such fills will remain with perpendicular walls for days.

It has been demonstrated that granulated slag, under proper methods of construction, is an excellent foundation material for paved streets and is the nearest approach to natural concrete. It can also be used in place of screenings to fill the voids of bank slag. The author has tried this with apparent success, although the work is too new to make an intelligent estimate of the value of such construction. In repairing a water leak on this street about two months after its completion the foundation had cemented together to a certain degree but very little strength had then developed.

As to cost, in the Pittsburgh steel district, where all foundation materials are shipped to the work, the weight of the different materials is approximately the same, therefore the freight is the same. The cost of handling is the same, while the cost of the slag is nothing, or some such small sum as $3 per car. By using granulated slag foundation the saving is approximately 30c. per sq.yd. of finished pavement.

In view of the above observations, the author would be pleased to see some experiment station, university or individual with proper apparatus undertake to examine and make tests of slag (especially granulated slag) as a road material, as an aggregate and a substitute for sand for concrete, and as a binder for other materials.

A Teredo-Proof Wood is available in Australia, according to C. S. Galbraith, Assistant Engineer of the Melbourne Harbor Trust. He states in an article in "The Commonwealth Engineer," that turpentine wood successfully resists the attacks of teredo navalis. This timber which has the botanical name, "syncarpia laurifolia," is a rather low strength hardwood common to New South Wales.

New Garbage and Refuse Incinerator for San Francisco

By L. H. Nishkian* and H. A. Minton†

SYNOPSIS—Data used in planning a garbage- and refuse-disposal system for San Francisco, Calif., are presented. The system adopted is outlined in a few words and then the Islais Creek Incinerator, the first unit in the system to be undertaken, and which has already been built, is described. This unit includes two 60-ton Heenan & Froude furnaces. Among the special features of this plant are: A storage pit or hopper large enough to hold a day's charges for the furnaces; a grab bucket, operated from an overhead electric monorail system, which discharges into steel containers over each furnace; hydraulic power from a pressure accumulator to operate the furnace-feed slide doors in the bottom of the containers, and also to push clinker from the clinker pits to the conveyor; electric power to charge pressure accumulators and to move grab buckets, to convey clinker, etc. The gases of combustion will be used to produce power, heat and light for the building, and ultimately it is expected that the surplus power will be used for general city purposes. The clinker will be crushed, screened, graded and stored for sale or for city use. In designing the steel framework of the building and the reinforced-concrete chimney, earthquake stresses were taken into account.

After the earthquake and fire of San Francisco, one of the chief works in the rehabilitation of the city was the provision of a garbage-disposal system to be operated by the municipality and to replace the privately owned and privately operated plant, which had not proven satisfactory.

The system in use at that time was one wherein the garbage was collected from residents by individual scavengers or groups of scavengers who were paid by the residents. These scavengers conveyed the garbage to the incinerator and paid the operators of the incinerator to have the garbage destroyed. [See Eng. News, May 17, 1900, for an account of litigation over the collection system and an illustrated description of the old Thackeray incinerators.—Ed.]

Much dissatisfaction had arisen among all concerned not only in the fixing of rates but also in the failure of the plant to incinerate garbage properly, and finally the plan was adopted whereby the city was to construct and operate its own incinerator and to buy out the privately owned and operated incinerator at a fair price.

In 1908, therefore, among other bonds, the people of San Francisco authorized the issue of bonds to the amount of $1,000,000 for a garbage-disposal system.

Of this amount, $400,000 was used to buy out the plant of the Sanitary Reduction Works‡. In the terms of the sale were the provisions that the Reduction Works should operate under the former conditions until the city had its first two plants in operation; and that the Reduction Works should pay all interest charges on the bonds until said time of operation of the proposed municipal plants, in return for the privilege of operating their own plant meanwhile.

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‡The name taken by the owners of the old Thackeray incinerator.—Ed.

Design of a System of Garbage Disposal

For the purpose of arriving at a comprehensive scheme for the disposal of the city's garbage, much time was spent in gathering data. As a result of this study, the city was divided into four sections: (1) That part of the city not yet fully developed—largest in area but smallest in garbage collected; (2) the wholesale district, smallest in area but very large in the amount of garbage collected; (3) retail-store and apartment-house district, large in area and in the amount of garbage collected; (4) Mission District, largest in population and large in amount of garbage collected.

The present plan contemplates three incinerators, one in Sec. 4, now completed; one in Sec. 2, about to be started, and one in Sec. 3, to be constructed within a few years. The garbage collected from Sec. 1 will be, for the present, divided between the two incinerators in immediate contemplation.

Nature and Amount of Garbage Collected

In San Francisco the scavengers make no separation of the garbage gathered; ashes, rubbish and food refuse are removed at the same time in the same wagon. Therefore, data of various sorts were gathered to acquaint the prospective bidders of the conditions likely to be encountered, the amount of garbage collected, its weight and volume, the percentage of its components, the average daily deliveries of refuse to the present works, the probable daily deliveries and capacities of the proposed plants, the percentage of combustible and incombustible matter in the garbage, and a comparison between the Borough of Richmond, N. Y., and San Francisco, as regards the heat value and composition of refuse.

Tables I to VI were, therefore, prepared:

TABLE I. DAILY REFUSE COLLECTIONS AT SAN FRANCISCO

Collection for the week ending 1908	Estimated quantities, cu.ft. Ashes	Garbage	Rubbish	Average unit weight of refuse in lb. per cu.ft. for the week	Average for the week of tons of refuse collected per weekday
Oct. 17	4,377	47,232	126,750	29.5	435
24	3,857	47,902	128,589	27.1	404
31	3,845	50,911	124,789	27.2	405
Nov. 7	5,216	57,150	118,104	28.0	419
14	5,529	65,202	105,862	27.9	408
21	4,541	63,083	109,436	28.2	413
28	8,210	55,361	111,040	30.2	434
Dec. 5	13,774	58,986	106,356	30.0	445
12	20,544	64,277	99,237	30.2	437
19	22,082	51,081	107,028	28.5	426
26	21,026	51,426	94,623	29.4	406
1909					
Jan. 2	21,525	57,429	97,323	29.4	427
9	18,954	69,009	93,593	31.4	471
16	14,728	61,682	91,704	33.4	466
23	13,712	67,759	97,562	33.9	502
30	14,341	74,004	85,216	33.0	474
Feb. 6	12,734	66,610	97,577	31.1	456
13	17,455	63,260	93,172	31.9	461
20	17,115	62,192	96,880	32.1	470

TABLE II. ESTIMATED PERCENTAGE BY VOLUME AND WEIGHT AND THE UNIT WEIGHT OF ASHES, GARBAGE AND RUBBISH IN SAN FRANCISCO

	Estimated percentage by volume	Estimated unit weight lb. per cu.ft.	Estimated percentage by weight
Ashes	8	41	10
Garbage	34	41	46
Rubbish	58	22	44
Total refuse	100	30.1	100

TABLE III. AVERAGE DAILY DELIVERIES OF REFUSE AT SAN FRANCISCO FOR EACH MONTH OF 1907, 1908 AND 1909

Months	Average deliveries, in tons per week day 1907	1908	1909
January	380	463	476
February	401	497	472
March	402	480	441
April	400	428	435
May	367	418	403
June	333	386	423
July	333	374	406
August	362	407	477
September	355	438	472
October	437	433	497
November	368	428	513
December	450	448	515
Average	383	433	460

TABLE IV. PRESENT AND STANDARD DAILY AVERAGE QUANTITY OF REFUSE COLLECTED AT SAN FRANCISCO AND CAPACITIES OF PROPOSED PLANTS

Section	Maximum quantity now collected, tons per day	Average quantity of refuse collected, in tons per week day: Present	Immediate future, estimated	Remote future, estimated	Proposed installation: Present	Future
1	49	28	40	285	0	300
2	189	126	140	390	180	360
3	299	223	240	480	240	480
4	82	56	80	245	120	240
Total	581	433	500	1400	540	1380

TABLE V. ANALYSES OF SAN FRANCISCO REFUSE

Date	Unit weight, per cu.ft.	Percentage by weight: Combustible	Incombustible	Moisture	Heating value, B.t.u. per lb.*: Comb. refuse	Refuse as collected
Dec. 7, 1908	31.1	22.65	26.45	50.90	10,836	2547
Dec. 10, 1908	29.5	22.46	25.37	52.17	10,540	2352
Dec. 17, 1908	27.0	23.34	29.53	47.13	10,588	2481
Dec. 29, 1908	29.6	23.06	27.71	49.27	10,330	2388
Jan. 28, 1909	32.2	23.16	28.37	48.47	10,230	2366
Average	29.7	22.9	27.2	49.9	10,530	2410

* Heating value determined from data obtained by a bomb calorimeter.

TABLE VI. COMPARING THE BOROUGH OF RICHMOND, NEW YORK, SEPTEMBER REFUSE, WITH THE SAN FRANCISCO REFUSE, AS REGARDS HEATING VALUE AND COMPOSITION

	Unit weight in lb. per cu.ft.	Percentage by weight: Combustible	Incombustible	Moisture	Heating value, B.t.u. per lb.: Comb. in refuse	Refuse as collected
Sept.—N. Y.	32.0	30.48	33.69	35.83	10,710	3265
S. F. Sec. 1	33.4	22.0	31.5	46.5	11,040	2425
S. F. Sec. 2	28.9	26.6	24.3	49.1	10,150	2709
S. F. Sec. 3	28.4	21.8	26.8	51.4	10,631	2312
S. F. Sec. 4	36.3	21.1	32.9	46.0	10,700	2247
Average S. F.	29.7	22.9	27.2	49.9	10,530	2410

REQUIREMENTS—The requirements to be fulfilled for each plant roughly resolved themselves into six divisions:

(1) The accounting of the garbage collected by the scavengers and delivered to the incinerator. This necessitates an office and a platform scale at the plant, where a clerk can keep a record of the garbage delivered and of the money paid by the scavengers for its destruction.

(2) The complete and inoffensive incineration of the garbage delivered. This requirement demanded the greatest care in the construction of the equipment and of the building, with particular pains taken to insure thorough combustion of refuse and gases, to provide adequate ventilation, to guard against escape of foul air, and to make satisfactory disposal of dust.

(3) The operation of the plant in the most economical manner. This requirement was the most essential in the basis of awarding the contract. It was important to employ mechanical means of operation wherever possible as the cost of labor was a very large factor. It was even more important to make the greatest use of the byproducts of incineration, such as the heat of combustion and the clinker. The boilers and machinery necessary successfully to accomplish this result are described hereinafter.

(4) The equipment of a laboratory for the study of conditions encountered. This was required with a view to the making of exhaustive tests from which it was expected much valuable information would be gained, to guide the city engineer in the design and construction of the other proposed incinerators.

(5) The equipment of a repair shop. This was to provide the plant with spare parts and means to keep the installation of the machinery always in operation.

(6) Provision for the needs and comforts of the operators. This was quite essential in view of the continuous operation of the plant.

In general, however, there was much latitude allowed the bidders. Results rather than the means of their attainment were of necessity the prime consideration.

Each bidder, therefore, had to fulfill the general requirements mentioned, to name the price for which he would install all the mechanical equipment for the incineration of garbage, and to state the cost per ton for which he would agree to incinerate garbage of various qualities.

The city agreed to construct the machinery foundations, the buildings necessary and the chimney.

GUARANTEES—Rigid guarantees, however, were required of the bidders, as follows:

The contractor agreed that when the plants were incinerating without additional fuel, at or about their rated capacity, refuse containing not more than 1000 lb. of water per ton, determined by an evaporation test, and not less than 460 lb. of combustible per ton, determined by a combustion test, the following conditions would be fulfilled:

(1) That no nuisance would be created in the normal operation of the plants;

(2) That no odors, obnoxious gases, smoke or dust would escape from the buildings or chimneys;

(3) That at no time during the normal operation of the plants, the temperature in the combustion chambers, due to defects in design or construction, and as ascertained from a continuous record during the time of testing, would fall below 1250° F., and that an average temperature therein of at least 1500° F. would be maintained;

(4) That the residue from the furnaces under a working load of 60 tons per unit per day as specified would be thoroughly burned hard and free from organic matter;

(5) That the flues, dust collectors, furnaces and combustion chambers would be so arranged that it would not be necessary to shut down any one unit for more than 48 hours in any one week, for the purpose of removing thoroughly all dust and ashes;

(6) That the pounds of refuse per hour which would be incinerated per square foot of the grate area upon which final combustion takes place would be not less than that stated in the contractor's bid;

(7) That the average cost per ton at each plant for incinerating refuse containing 1000 lb. of water and 460 lb. of combustible, computed according to certain specified rules, would not be greater than stated in the contractor's bid.

The contractor further guaranteed to keep the plants in effective operation for one year from the dates of their respective acceptances, and during this period to furnish all labor and material for repairs necessitated by defective design or workmanship.

BASIS UPON WHICH AWARD OF CONTRACT WAS TO BE MADE—The award of the contract was made upon the basis of the annual fixed charges, plus the annual operating cost of incineration. The annual fixed charges were assumed to be 10% of the total cost of the equipment of the plant, and the annual operating cost of incineration was estimated by multiplying the estimated number of tons of garbage per year by the net cost per ton guaranteed by the bidder. A bonus and damage provision was made part of the contract to give the contractor an incentive to incinerate the garbage below the guaranteed net cost and to protect the city from loss resultant upon the incineration of garbage above guaranteed net cost.

ISLAIS CREEK INCINERATING PLANT—The present plant, therefore, called for proposals to construct two incinerators, one in Sec. 4, called the Islais Creek Incinerating Plant, and one in Sec. 2, called the North Beach Incinerating Plant. Each plant was to have a capacity of incinerating 120 tons of mixed refuse daily. The requirements were the same for each plant, with the exception that the Islais Creek plant was to be constructed as a com-

plete installation, whereas the North Beach plant was eventually to be increased to a capacity of incinerating 360 tons of garbage daily, although, for the present, furnaces for the incineration of 120 tons only were to be installed.

As the work is already completed on the Islais Creek plant, and has not yet been commenced at the North Beach plant, references will be made only to the Islais Creek plant. A view of this plant at the time of its completion is shown by Fig. 1.

After the contract had been let and considerable study had been given to the machinery and its operation, several changes from the original design were made. Many of these changes were in details of construction and mechanical parts only. Some changes, however,

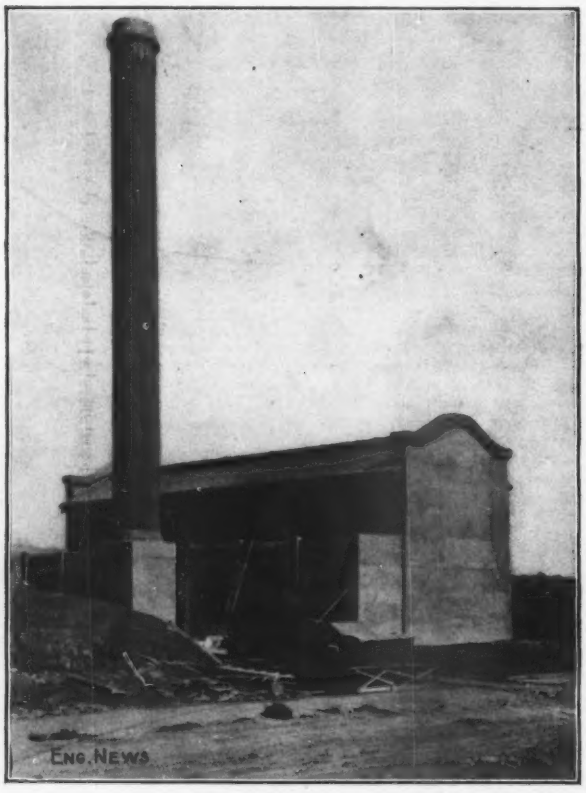


FIG. 1. ISLAIS CREEK GARBAGE INCINERATOR, SAN FRANCISCO

(The chimney and buildings were finished by the cement-gun method.)

involved larger features of the design. The original design contemplated the deposition of the garbage from the wagons upon a shaking conveyor, which fed the garbage into metal containers. These containers, when loaded, were to be lifted by means of a traveling crane to the storage floor over the furnaces, and were to be dumped into the furnaces mechanically. This scheme was abandoned for the present one of dumping the garbage from the wagons into a container pit, lifting it by a grab-bucket operated by a trolley traveling above the axes of the furnaces and depositing the garbage immediately into the hopper or trough over the furnaces. These changes eliminated considerable labor in handling and cleaning the containers, and added greatly to the efficiency of the plant. Furthermore, the change resulted in a reduced cost of the building proper, a net gain to the city.

Another change in plan was effected in the handling of the clinker from the furnaces. The original design called for a continuous conveyor in the clinkering alley behind the furnaces, which fed the clinker to a clinker crusher. This was discarded for an electrically operated dump car, which runs on tracks behind the furnaces and feeds automatically into the clinker crusher. Considerable saving in space and cleanliness was the result of this change, in addition to the gain in efficiency by reason of the lesser liability to failure in operation.

THE GENERAL SCHEME—The plant consists of a group of two buildings. The main building (see Fig. 2 for plan of clinker floor) contains the office and garbage pit for the refuse delivered, two four-grate furnaces for the incinerating of the refuse, each furnace provided with a boiler for the generation of power, the machinery, or pump, room for the electric generating set, two blowers for the ventilating system, feed-water heaters, feed pumps and oil pumps, the repair shop for all tools, the laboratory for tests, the kitchen for the men, and all necessary sanitary conveniences. The secondary building is primarily for the storage of crushed clinker, but since the storage bins of necessity had to be elevated, use is made of the space below for the installation of a pressure accumulator to operate the hydraulic rams in the main building, a baling press which bales all tin, etc., rejected from the clinker screen, and the men's locker and shower room. This building is about 26x53 ft. in plan, over all, and the greater part of it is two stories high.

The structural work presented no unusual problems. A garbage pit 30 ft. deep, a chimney 150 ft. high, the main building housing the furnaces and boilers, and the clinker-storage building are the main features.

GARBAGE PIT—From records kept for a certain period it was ascertained that the delivery of garbage to the incinerator was not constant during the 24 hours. Approximately 75% of the garbage is delivered during eight hours. It was necessary, therefore, to design a garbage pit of sufficient capacity to contain a full day's delivery or 120 tons, so that the feed to the furnaces can be kept regulated for 24 hours, regardless of the supply to the plant. A further advantage of the large pit is its ability to store a full day's delivery of garbage in case of a breakdown of the furnaces. The details of this pit are shown by Fig. 3.

It was apparent that this pit would be a likely place for the accumulation of filth. The greatest care, therefore, was taken to finish it in as smooth a manner as possible, so as to prevent the adhesion of small particles of garbage to its sides. A most satisfactory finish was obtained by troweling the cement gun mortar as soon as it was shot into place. The sides of the pit were protected from possible injurious bumps of the grab bucket by placing buffer rails of steel in the concrete along the line of the grab-bucket's travel. The bottom of the pit was fitted with removable cast-iron strainers through which all liquid matter in the garbage drained into a gutter which led it to a sump. The sump and gutter were located in an inspection chamber on one side of the garbage pit accessible from the upper level through a shaft containing a ladder. In the sump was placed an automatic bilge pump which carried all matter deposited in the sump to the main sewer above.

For the purpose of giving the garbage pit, the sump and its accessories a thorough cleaning as often as it should be found necessary, a water-supply pipe and a live-steam pipe were carried down to the inspection chamber at the bottom of the garbage pit. It was figured that a scouring of the pit with steam and water about once each week would keep everything in perfect order.

The factor one-fifth is obtained from the measurement of the acceleration of the earth's surface during an earthquake. It is found that this acceleration is approximately 6 ft. per sec., or about one-fifth the acceleration due to gravity. A strict analysis of stresses due to earthquakes would, of course, take into account the oscillation frequency of the structure and of the earth's surface, but the

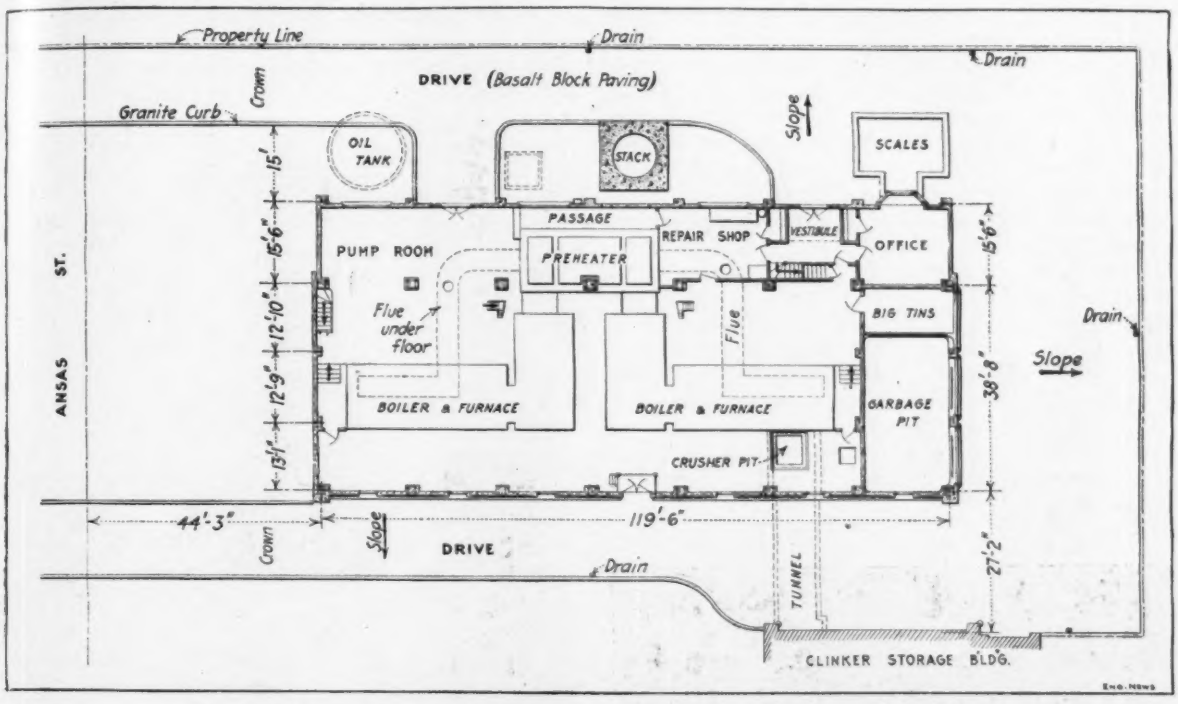


FIG. 2. PLAN OF CLINKER FLOOR OF SAN FRANCISCO GARBAGE INCINERATOR

The side walls of the garbage pit were designed as slabs with the main reinforcement running horizontally. Although the excavation was in rock the walls were designed for water pressure on the lower 20 ft., and earth pressure above. During construction a spring of water was encountered on the site of the garbage pit, thus justifying what might have appeared to be unduly heavy construction.

CHIMNEY—The chimney is of reinforced concrete, 150 ft. high above the reinforced-concrete foundation, which is octagonal in plan, 30 ft. between opposite sides at the face and 4½ ft. deep. The chimney is 9 ft. in internal diameter, and brick-lined for some two-thirds of its height. Figs. 4 and 5 show the chimney under construction and Fig. 1 shows it completed.

In designing the chimney two conditions of loading were assumed: (1) A wind load of 30 lb. per sq.ft. on the projected area of the chimney surface, and (2) an earthquake load assumed to be equivalent to one-fifth the weight of the chimney, acting horizontally.

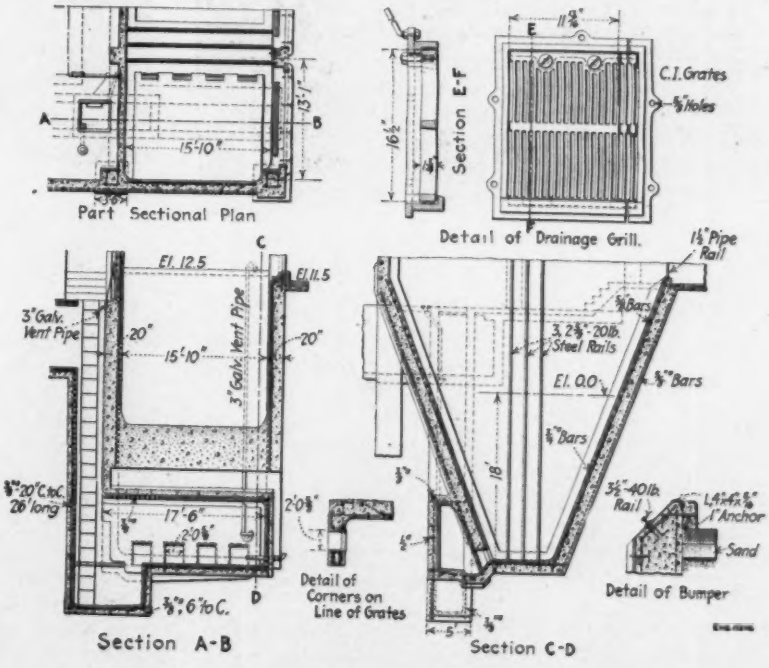


FIG. 3. DETAILS OF GARBAGE PIT, SAN FRANCISCO GARBAGE INCINERATOR

complicated nature of such calculation, coupled with the many unknown conditions—such as elasticity of the materials concerned, the duration of the earthquake, the possibility of simultaneous wind load, etc., would make such an analysis impractical.

The earthquake loading was found to be the governing condition, being equivalent to a wind load of 45 to 65 lb. per sq.ft. of projected surface of the chimney, varying with the height, the larger equivalent wind loads occuring in the lower sections.

The concrete shell of the chimney was made 12 in. thick at the lower end, and 5 in. thick at the upper end, and the necessary steel was obtained by the use of the diagram given by Turneaure and Maurer. The ring reinforcement was designed for a difference in temperature of 250° F. between the two surfaces of the concrete shell.

The main building consists of a long open structure, housing the incinerators and boilers, with a lower flat roof structure appended on one side and used for the offices, the engine room and the repair shop. It was the original intention to build everything of reinforced concrete, but on account of the suspended crane with a carrying capacity of 15,000 lb. in addition to a dead load of about 8000 lb., it was decided to use steel trusses.

The supporting columns were made of four light latticed angles in order to provide a good connection between the columns and trusses and also for convenience in the erection of the walls and trusses.

The columns were designed for earthquake stress, using

FIG. 4. REINFORCING STEEL IN BASE OF CHIMNEY OF SAN FRANCISCO GARBAGE INCINERATOR

a method similar to that described for the chimney, i.e., one-fifth their weight was assumed acting horizontally. the column being considered fixed as regards deflection top and bottom. The structural steel in the columns was calculated as that much reinforcing steel.

The remaining portions of the plant presented nothing but ordinary problems of designing.

The stresses used throughout in designing were as follows

Steel, reinforced and structural	16,000 lb. per sq.in.
Concrete in compression	650 lb. per sq.in.
Concrete in compression, for earthquake stress	750 lb. per sq.in.
Concrete in shear	40 lb. per sq.in.

On account of the momentary action of earthquake stress, it was deemed proper to use the higher stress in concrete stated above.

DAMP PROOFING AND FINISHING—The concrete surfaces of the buildings both inside and outside were finished with cement plaster applied by means of the cement gun. The most interesting portion of this work was the plastering of the 150-ft. chimney. The compressor and gun were located on the ground, and the water was forced to the top of the stack by a small Worthington pump. The air pressure never exceeded 75 lb., and no difficulty was experienced in applying the materials under these conditions. Patent scaffolds were hung from three 6-in. I-beams placed over the top of the chimney. This particular part of the work was done in less than four days.

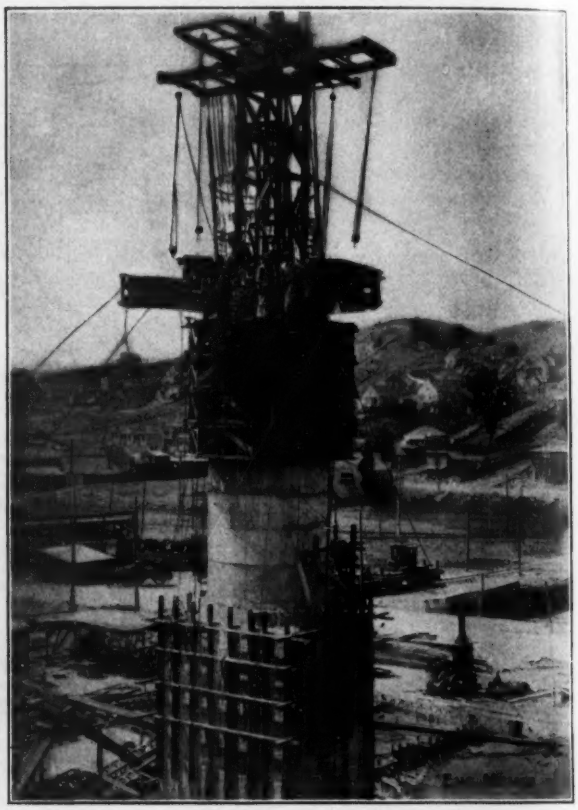


FIG. 5. SAN FRANCISCO GARBAGE INCINERATOR CHIMNEY UNDER CONSTRUCTION

(Jorgensen patent forms were used; 3 ft. of concrete were poured each day and the forms for each day were not removed until the fifth day following.)

The cement-gun finish has proved entirely satisfactory in durability, and no surface cracks or checks have been apparent.

This finish was used for waterproofing the garbage pit, the bottom of which is 20 ft. below high water. Up to the present time no leaks have been discovered in this work.

ARCHITECTURAL WORK—The architectural style of the incinerator is a free adaptation of the old Spanish Mission style. The large windows, necessary for the admission of the greatest amount of sunlight, give an effect not wholly in harmony with the traditions of the style, but the general aspect of the buildings conforms to that of the Mission in repose, simplicity and color. The large wall surfaces and the red tile roofs of the buildings are elements of the design usually found in examples of this style.

The interior of the building is designed for cleanliness

in appearance as well as utility. The general color scheme inside is white and green, and the effect is extremely pleasing.

The result is appreciated and it is admitted that the Islais Creek incinerator in San Francisco is probably the finest equipment of its kind, housed in buildings far beyond those in use for this purpose elsewhere.

HANDLING OF GARBAGE—Mixed refuse will be delivered to the incinerator in wagons, containing on an average 140 cu.ft., and weighing on an average 5000 lb. The refuse will first be weighed on a platform scale at the plant and will then be dumped into concrete garbage pit.

From the garbage pit the refuse will be lifted by means of an electric traveling crane, equipped with a grab-bucket having a maximum capacity of 36 cu.ft. and dropped into steel containers located on top of the furnaces.

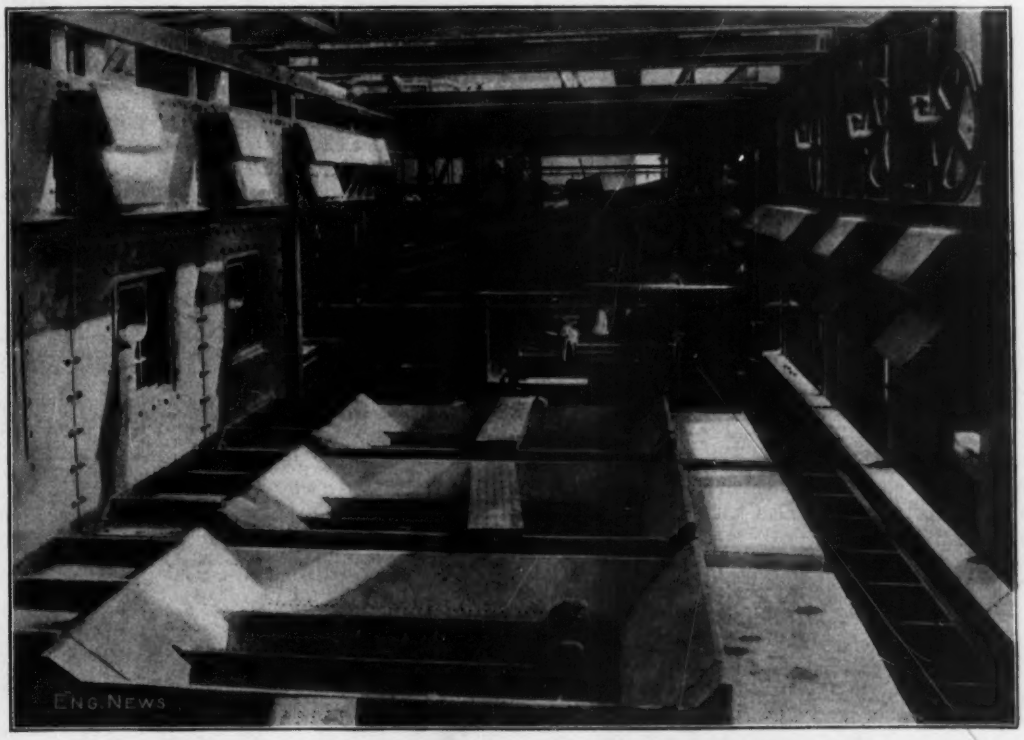


FIG. 6. INTERIOR VIEW OF GARBAGE INCINERATOR AT SAN FRANCISCO, CALIF.
(The perforations for admitting air in the burning grates are shown, particularly in the foreground. The boiler tubes may be seen in the rear.)

These containers are an integral part of a contiuuous steel trough and are located directly below the trolley of the electric crane, extending from the edge of the garbage pit to the extremity of the furnaces. All droppings from the grab-bucket, therefore, will be received by the trough. Platforms are provided along both sides of the trough to permit whatever handling of these droppings may prove necessary.

The containers are equipped with sliding doors at the bottom, operated by rams, by means of which the mixed refuse will be dumped upon the drying hearths over and behind the grates upon which the refuse is to be incinerated. After being dried, the refuse will be raked forward onto burning grates by stokers.

INCINERATION—Each furnace (see Fig. 6 for general interior view) has four grates separated by brick walls, pierced with arched passages, through which the gases resulting from incineration of the garbage will pass to a combustion chamber. The combustion chamber has a cubical content about equal to the combined contents of the four grate chambers. In the combustion chamber a temperature will be maintained sufficient to mix and consume all combustible matter which may escape the grate chambers.

The combustion chamber of each furnace is separated from the boiler setting by an arched brick passage through which the hot gases are admitted to the heating surfaces of a water-tube boiler. The flue from the boiler setting leads the gases, partially cooled by their contact with the heating surfaces of the boiler, into the chamber which contains the tubular air heater. After passing around and over the tubes of the air heater, the gases, still further cooled by the process of heating the ingoing air, are led to the dust-settling chamber. The dust from the gases is caused to drop by a complete change in direction of the flow of the gases. Finally, from the top of the dust-settling chamber the gases pass to the chimney.

The supply of air necessary for the incineration of the refuse is drawn by means of a Bowie pressure blower from those parts of the building where the foul air is likely to accumulate. This air is heated by a process comparable to that by which the hot gases are cooled. The air is discharged under pressure first through the tubes of the air heater, where it is warmed by the hot gases passing around and over the tubes. From the air heater it is led through ducts under the floor to the clinker-cooling chamber below each furnace grate. By passing upward through the hot clinker, it gains more heat and flows through the burning grates to the refuse deposited

thereon. From this point it follows the course of the hot gases, over the grates, through the combustion chamber, through the boiler, air heater and dust-settling chamber to the chimney.

Each 60-ton incinerating furnace is installed as a separate unit, so that it may be operated or shut down and any part cleaned, overhauled or repaired without interfering in any way with the operation of the other furnace.

Disposal of Clinker

After being partially cooled in the chamber beneath the burning grates, the clinker will be discharged by means of a ram through suitable doors provided for the purpose, into a clinker car in which it will be conveyed to a clinker crusher.

After the clinker is crushed, it will be fed into a continuous conveyor operated by an electric motor and located in the tunnel connecting the main building with the clinker-storage building. This conveyor will deposit the crushed clinker in the boot of a continuous bucket elevator which feeds into a revolving screen located above the clinker-storage bins. The screen will grade the crushed clinker into three sizes, ½, 1½ and 2 in., and discharge the graded material into concrete bins in the clinker-storage building.

This clinker will weigh about 40 lb. per cu.ft. It is believed that this will prove an excellent material for making a light-weight concrete. On account of the high temperature to be maintained in the furnaces, no substance injurious to reinforcing steel will be left in the clinker.

Power Generation—The hot gases from each furnace pass through a Babcock & Wilcox semimarine type of boiler having 1700 sq.ft. of heating surface and about 160 hp. rating. It is expected that about 300 hp. will be available. At present this power will be used only for the operation of the plant, and the lighting and the heating of the buildings. It is expected that, in the future, the excess power will be used in conjunction with a power plant for the operation of municipal utilities.

The pressure blower, all the machinery for handling the clinker and the accumulator pumps will be driven by electric motors operated by direct electric current at 250 volts.

The boiler-feed pumps, the fuel-oil pumps and the turbines operating electric generators will be driven by steam from the boilers connected with each furnace.

The moving parts of each furnace, with the exception of the stoking doors and the ash-pit doors, which are operated by hand, are controlled by water power furnished by a pressure accumulator.

Direction of Work

The work on the Islais Creek Incinerator was begun under the direction of Marsden Manson, former city engineer, and was completed under the direction of M. M. O'Shaughnessy, present city engineer of San Francisco. Rudolph Hering, of New York City, was consulting engineer on the selection and design of the system.

Contracts

The excavation (not including the garbage pit) and foundation work in filled ground, was done by the Mercer Fraser Co. for the contract price of $12,429. The buildings and chimney complete were constructed by McLean, Haggans & Aden for the contract price of $62,155. The structural steel (which included the columns and roof trusses) was furnished and erected by the Judson Mfg. Co. for the contract price of $6500. The contract for the mechanical equipment for the Islais Creek Incinerator was awarded to the Destructor Co., of New York, for $123,141.

The terms of the proposal submitted and accepted for this contrast were as follows:

Cost per ton that the bidder guarantees as the net cost of incinerating refuse containing one thousand (1000) pounds of water and four hundred and sixty (460) pounds of combustible per ton at the Islais Creek Station, twenty-five and one-half cents ($0.255).

Amount that the bidder directs his guaranteed net cost per ton of incinerating refuse at the Islais Creek Station to be decreased for each pound of combustible per ton contained therein exceeding four hundred and sixty (460) pounds as shown by the test, provided the refuse contains between four hundred and sixty (460) and five hundred and twenty (520) pounds of combustible per ton, sixteen one hundredths cents ($0.0016).

Amount that the bidder directs his guaranteed net cost per ton of incinerating refuse at the Islais Creek Station to be decreased for each pound of water per ton contained therein less than one thousand (1000) pounds as shown by the test, provided the refuse contains between one thousand (1000) and nine hundred (900) pounds of water per ton, twenty eight one thousandths cents ($0.00028).

Amount that the bidder directs his guaranteed net cost per ton of incinerating refuse at the Islais Creek Station to be increased for each pound of combustible per ton contained therein less than four hundred and sixty (460) pounds as shown by the test, provided the refuse contains between four hundred and sixty (460) and four hundred (400) pounds of combustible per ton, sixty-four one hundredths cents ($0.0064).

Amount that the bidder directs his guaranteed net cost per ton of incinerating refuse at the Islais Creek Station to be increased for each pound of water per ton contained therein exceeding one thousand (1000) pounds as shown by the test, provided the refuse contains between one thousand (1000) and eleven hundred (1100) pounds of water per ton, one hundred twelve one thousandths cents ($0.00112).

Number of pounds of refuse per hour containing not more than one thousand (1000) pounds of water and not less than four hundred and sixty (460) pounds of combustible per ton that the bidder guarantees will be incinerated at the Islais Creek Station per square foot on the grate area upon which final combustion takes place, eighty three and one-third (83⅓) pounds.

Probable gross rate of evaporation in the boilers at the Islais Creek Station from and at two hundred and twelve (212) degrees Fahrenheit per pound of refuse consumed, the refuse to contain not more than one thousand (1000) pounds of water per ton and not less than four hundred and sixty (460) pounds of combustible per ton, one (1.0) pounds.

Safe Operation of Reduced-Speed Sections on Railways*

Every place on a railway at which speed has always to be reduced is more or less a place of danger. But if the speed is reduced as much as is necessary, the safety of working is fully restored. In many cases the train takes only a few seconds to run over the reduced-speed section, which may be very short, but none the less dangerous. If the speed has not been specially measured on the locomotive or on the track, it is impossible to prove whether the authorized maximum speed has been exceeded.

Even the fastest train is compelled to stop by an absolute stop signal, while at a reduced-speed place it is required only to reduce its speed to some extent. A further source of danger is in the dislike enginemen have for reduced-speed places. These reduced-speed places are of two kinds: Permanent and temporary. The difference in their influence on the safety of working is that the presence of the former is known to the locomotive crews, while the presence of the latter involves an additional risk, as means must be taken to inform the men of their existence. Local factors which make full-speed running impracticable are: Entrances of stations, points where no clear view can be obtained, constructive works such as bridges and tunnels, railway grade crossings, and junctions.

The speed on grades and curves is generally specified in the regulations. With varying grades and with curves of varying radii, there may be great variety in the maximum speeds which are to be observed. It is advisable to reduce this

*Abstract of a paper by Hans A. Martens, State Engineer, in the "Zeitung des Vereins Deutscher Eisenbahnverwaltung," and reprinted in the "Bulletin" of the International Railway Congress. A comment on this subject is given in another column.—Editor.

variety as much as possible, and small variations in the speed limits are of little practical value. The safety of working is increased by reducing the number of reduced-speed places, and the elimination of even a single such place may be of great value.

In many cases a careful examination of the local conditions may show the possibility of improvements. Thus, the capital outlay on easing grades and curves may be counterbalanced not only by greater safety of working, but also by reduced cost of traction. It is also to be hoped that in course of time diverging switches will cease to be an obstacle to the full speed of express trains, as for experimental runs at 62 m.p.h. have been made successfully over switches.

In many cases it will be possible to eliminate speed reductions prescribed because no clear view can be obtained of the track, especially at the entrances of stations, by improving the signaling arrangements. Thus, with better position for the home signals they can be seen from a greater distance, giving better protection of the through main lines during switching operations.

PERMANENT SPEED-REDUCTION POINTS

For notifying enginemen of the permanent speed-reduction points three methods are in use: 1, A table containing a list of the reduced-speed places is embodied in a special order handed to the men. 2, Notice boards at the beginning of the reduced-speed places. 3. Signals at the beginning of the reduced-speed places.

Listing the reduced-speed places has the advantage of conciseness, and of being very suitable for teaching purposes. But if these places are not brought to the notice of the men in any other way, it is to be feared that an engineman who seldom takes a train over the section may not always think of them. When men change from freight to passenger service, there is also the risk that they will not remember the reduced-speed places for the fast trains.

But this forgetting of the places is equivalent to taking no notice of them and this again means reduced safety of operation. In order to draw the attention of the enginemen to the importance of these reduced-speed places, they should be made an examination subject. Knowing the reduced-speed places is quite as much part of the knowledge of the line, as knowing the signals and the stations.

The author has recommended that they should be indicated on all time-tables by appropriate symbols to indicate that owing to curve, down grade, bridge, entrance of station, etc., the given speed limits must not be exceeded.

Owing to the uncertainties which remain if the reduced-speed places are notified in the printed orders only, it is advisable to place notice-boards at the beginning of these places, with the speed limit marked on them in large, bold type, so as to be legible from a distance. This is a good and effective reminder, which shows exactly where the place begins. The notice-board is not illuminated at night; the light of the locomotive lamps makes it sufficiently visible. If a section of line were to have an undue number of speed-boards this would indicate a want of congruity between the local conditions and the running speed of the trains.

Some engineers would go further, and put up signals. Then there can be no ambiguity in the order to reduce speed, and the place cannot be forgotten unless the signal is not noticed. One disadvantage is that this means having more signals. There is a general tendency to have as few signals as possible, so as to simplify signaling and reduce the tax on the men's memory, and therefore the general introduction of signals at reduced-speed places cannot be considered advisable.

WARNING OF TEMPORARY POINTS OF SPEED REDUCTION

The temporary reduced-speed places are generally caused by intentional or accidental alterations in the track, such as work on the track or roadbed or such natural events as land-slides or wash-outs. The reason for the reduced speed is the weakened condition of this track. This is a well marked difference as compared with the permanent reduced-speed places; and the risk of an accident due to overstraining the track by using too high speeds, is accordingly greater on temporary than on permanent reduced-speed places.

The risk is also greater because it is not always possible to inform the enginemen of the exact position, while this position changes as the work progresses. This is the reason why signals are always used to mark temporary reduced-speed places, and this is a problem which is difficult and not always solved satisfactorily. The day signals, disks, notice-boards and flags, are not high enough above rail-level and hence not properly visible from a distance.

No attempts have been made to develop a system of emergency signals on the principles which are recognized as standard in the case of ordinary signals. But it is advisable to begin to make experiments to determine a suitable shape for an emergency reduced-speed or stop signal visible from a distance. This can be done only with the help of a sufficiently high post, and two important desiderata in its design are lightness and collapsibility. The signals now in use, placed at the side of the bank or along the ditches, and often extending barely above rail level, can hardly be considered satisfactory, considering the high speeds of present-day traffic. The same remark applies to the night signals.

The location of the reduced-speed signals also requires consideration. The signal should be placed a certain distance ahead of the reduced-speed place, equal to say the braking length of the fast trains, and both the beginning and the end of this place must be marked accurately. In many cases the beginning is not marked, probably in the interests of simplicity. This tends to make the enginemen think that it is unnecessary to pay great attention to the reduced-speed places. Moreover, at night the uncertainty is increased and the engineman, as a rule, only notices the reduced-speed place in consequence of the change in the running of his engine. An important requirement is that the train should run over the place in question without the brakes being on, and in order to satisfy this requirement, the beginning of the place must be marked.

At the suggestion of the author the following experiment was tried. At the beginning of a section which was being rebuilt a white triangular notice-board was put up, with red lettering "Rebuilding." It was placed at the height of the engineman's eyes and was very visible by day and also by night, being illuminated by the locomotive lights. The men stated that this sign was satisfactory. Notice-boards fully suffice for the beginning and the end of the reduced-speed places. If a signal is used, however, it should be set a certain distance ahead of the reduced-speed place, so as to act as a distant signal.

A precaution of considerable importance when track is being rebuilt, is to arrange the work in the day so that reduced-speed signals are unnecessary in the night. But it is not always possible to do this. The safety of working is much improved if the responsibility, especially as regards the putting up of signals, is assigned to definitely named employees.

OBSERVANCE OF SPEED-REDUCTION SIGNALS

The enginemen regard reduced-speed places as very objectionable. The chief reason for this is probably because the reduction of speed frequently leads to loss of time which it is often impossible to make up. If a reduced-speed place is run over at undue speed, it by no means follows that an accident or any trouble will result, and this naturally leads the drivers to the dangerous belief that many of the reduced-speed regulations are superfluous and may be disregarded. But some day there may be unfortunate coincidences and a cumulation of errors, resulting in an accident.

One means of obtaining a check upon the observance of the regulations is to measure the speed on the train by means of a stop-watch or chronograph. This can only be done occasionally; nevertheless it is highly recommended to the locomotive and traffic officials. But the good education and training of the men are worth more than checking devices. To begin with, the attention of the beginner must be drawn to the importance of being able to estimate the speed correctly, and it is advisable to make speed-estimating one of the subjects in the practical examination of the engineman.

SUMMARY

A review of the conclusions as to methods of protecting traffic on slow-speed sections of main lines suggests the following for consideration:

1. As few reduced-speed places as possible;
2. As few varieties of reduced-speed as possible;
3. Notice-boards at permanent reduced-speed places;
4. Indication, in the time-tables, of the reduced-speed places;
5. Signals visible from a distance, at temporary reduced-speed places;
6. Signs to show where these places begin;
7. Doing away with temporary reduced-speed places at night, as far as possible;
8. Insuring that the locomotive men are kept informed of the temporary reduced-speed places;
9. Speed-recorders on locomotives;
10. Sufficient extra time allowed in the time tables for reduced-speed places of all kinds;
11. No blame to attach to the engineman if he is compelled to lose time in consequence of reduced-speed places;
12. Frequent occasional tests, when running over reduced-speed places, made by supervising officials on the train;
13. Proper training of the enginemen.

Steelwork of the Lower Ganges Bridge, at Sara, India

By F. C. Coleman*

One of the most interesting, and by far the most costly, of all the engineering schemes now in hand in India and the Far East is the new railway bridge to carry the main line of the Eastern Bengal State Ry. over the Ganges River at Sara Ghat, which is about 118½ miles distant from Sealdah terminus, Calcutta.

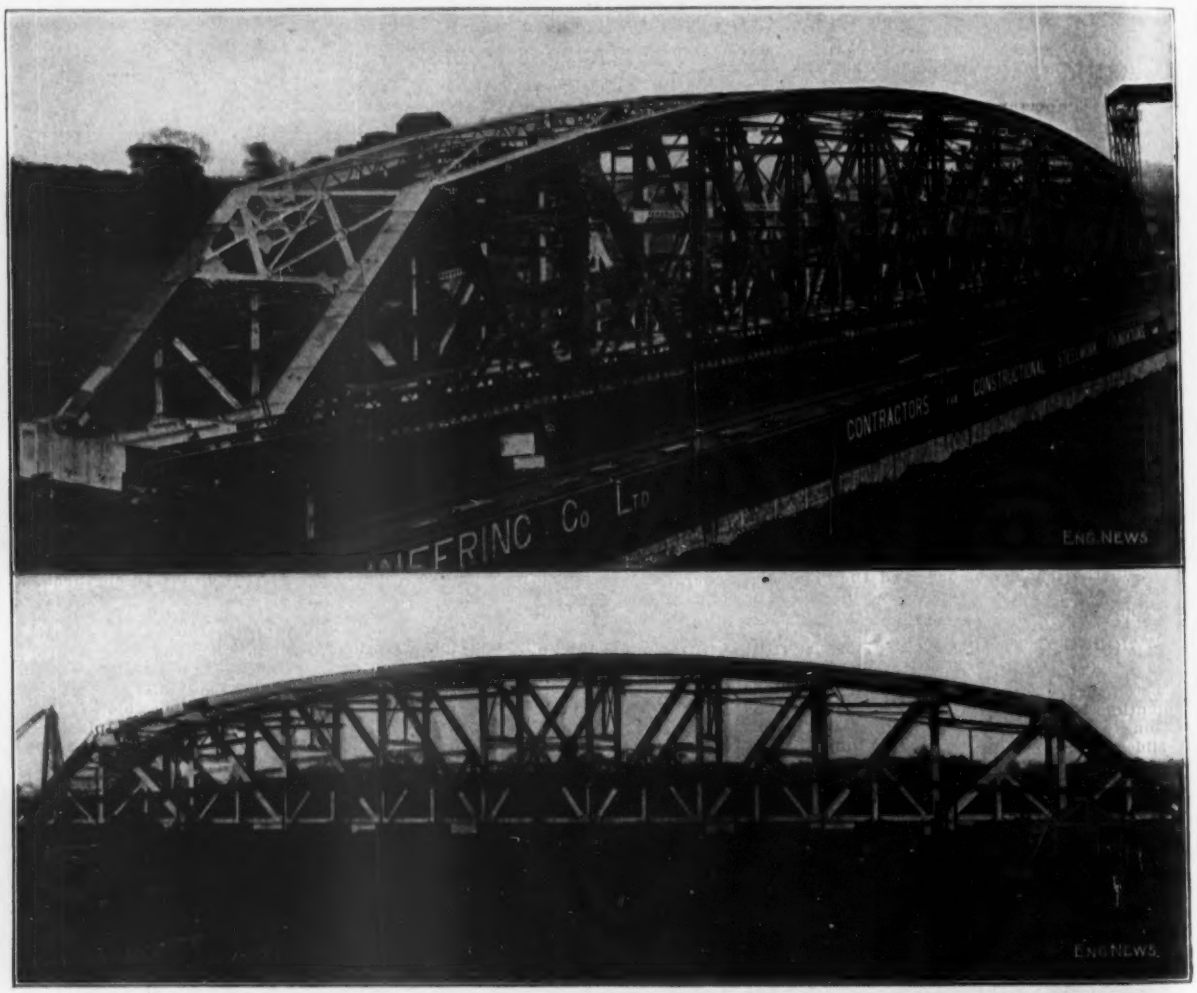
[Two articles on this bridge have appeared in Engineering News, the first, Nov. 9, 1911, p. 553, gave a general description of the site and of the foundation and bank-protection work, the second, Sept. 4, 1913, p. 460, by M. D. Brayshay, one of the Assistant Engineers on the work, outlined the progress in construction that had been made up to that time.—Ed. Eng. News.]

The bridge consists of 15 through-truss spans, each 359 ft. c. to c. of piers and six plate-girder deck-approach spans, each 95 ft. long, making a total length of bridge of 5890 ft., carrying a two-track broad-gage railway line, a footpath on buckle-plates between tracks and a narrow footway on cantilever brackets outside the down-stream truss. The accompanying halftones are from photographs of one of the spans as it was set up in the yard of the Cleveland Bridge & Engineering Co. at Darlington, Eng., previous to shipping the members to India.

The main trusses have an overall depth at the center of 52 ft.; the width, c. to c., is 32 ft., and the total width of the bridge, including the footway, 48 ft. 6 in. The main posts are spaced 31 ft. 4½ in. c. to c., and a sub-system of bracing reduces the distance between the cross-girders to 15 ft. 8¼ in. Each main post is braced at the center by a latticed strut running to the junction of the subdiagonals and verticals. The chords are built of plates and angles, and each of the largest sections exceeds 43 ft. in length and 16 tons in weight. The main posts and diagonals are built up of angles and plates and they are laced with small channels. A feature of the sub-posts and diagonals is that they are composed of bulb angles diagonally laced with steel tubes having flattened ends. This tube lacing is new in British practice, and forms a rigid system giving a maximum strength when used in the form of a strut.

The floor of the bridge is of the open type, the rails being carried on ties laid on longitudinal timbers resting

*Central Station Hotel, Newcastle-on-Tyne, England.



Figs. 1 and 2. One of the 359-Ft. Spans of the Sara Bridge, India, Set Up in the Bridge-Shop Yard in England

directly on the stringers. Including the footway, but excluding the bearings, the total weight of each of the 15 main spans will be no less than 1216 tons. The bearings, which alternate fixed and expansion, are of the rocker type. At the fixed ends of the spans the bearings are made in two pieces, a high pedestal bolted to the trestle top and a saddle bolted to the underside of the bearing

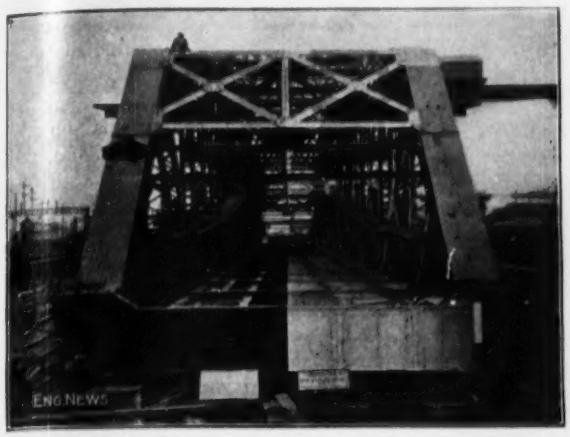


FIG. 3. END VIEW OF A SPAN OF THE SARA BRIDGE

plate of the span. At the expansion ends the bearings are in three parts, a low pedestal and saddle bolted as before noted, and a rocker with knuckle ends fitting into sockets on both pedestal and saddle.

The whole of the structural work comprised in the Lower Ganges Bridge will be built in accordance with the British standard specification for structural steel bridges and to detailed designs prepared by Messrs. Rendel, Palmer & Tritton, of Westminster, London S. W., the Consulting Engineers to the India Office. Nine of the 15 main spans are being built by the Cleveland Bridge & Engineering Co., Ltd., of Darlington, Eng., and the remaining six by Messrs. Braithwaite & Kirk, Ltd., of West Bromwich, Eng. To facilitate erection at the site, each half of each of the 15 spans will be painted by the contractors in a different color. In the accompanying views it will be noted that each half of the span is painted in a distinctive color.

Severe competition for the steelwork was encountered by the British builders from the leading American bridge companies, and the contract represents the most important individual steel bridge order placed during recent years in Great Britain for any part of the world. The bridge will rank as the heaviest steel structure carried out by British engineers since the completion of the Forth Bridge. The substructure work and the erection of the steelwork are being carried out by the Indian Government staff under the personal direction of R. R. Gales, as Engineer-in-Chief, and according to the designs prepared by Sir Alexander Rendel, acting as Consulting Engineer.

A Very Large Firebox of the stayless sectional type has been designed for the "consolidation" locomotives of the Philadelphia & Reading Ry. and a large number are being built by the Jacobs-Shubert U. S. Firebox Co., of New York. These boxes are 13 ft. 2 in. long and 8 ft. 8 in. wide inside and are made up of 15 channel-shaped sections 10 in. wide. The bottom of the mud ring is 5 ft. 1 in. below the center of the crown inside. The locomotives burn anthracite and require a large grate area. These fireboxes will have a bridge wall forming a combustion chamber with the back-flue sheet.

Pressure Integrating Device for Attachment to an Engine Indicator

A device for the purpose of determining with ease the mean indicated horsepower of any reciprocating unit—whether steam engines, Diesel or other internal-combustion engines, gas engines, pumps, etc.—is now upon the market. The device, known as Böttcher's Power Counter, is attached to a Maihak indicator and counts every stroke of the engine. The manufacturer guarantees its operation on engines whose speed does not exceed 400 r.p.m.

There are two arrangements of the indicator and "counter," known as type *A* and type *B*. With the former, one or more check-diagrams can be taken on a single diagram-sheet during the period of counting; while in the case of the latter, the diagram-sheets may be changed while the "counter" is in operation, allowing an unlimited number of check-diagrams. The general construction features of both types are similar, and appear much the same as the ordinary indicator with the addition of an integrating device which operates on the flat-top surface of the drum. A roller on an arm oscillates radially with reference to the drum by means of link work from the indicator piston-rod. The travel of the working-wheel is governed by the stroke of the indicator piston and consequently is proportional to the mean effective pressure.

Paper diagrams need not be taken at all, except to check the integrator when desired. All that is required, then to determine the indicated horsepower of a given engine is to note the reading on the integrating apparatus at suitable intervals; and by the substitution of this and the elapsed time, in familiar formulas involving constants for the apparatus and engine, respectively, the horsepower is computed.

These instruments are sold in the United States by Herman Bacharach, of Philadelphia, Penn.

Highway Administration and Politics in Indiana—Indiana is notable as being one of our richest agricultural states, also as being one of the very few which has no state engineering or highway department. Hence this state is far behind all its neighbors in highway improvement. At the recent session of the state legislature an attempt was made to better existing conditions by passing a law which provides for the appointment by the County Commissioners of each county, of County Highway Superintendents. The county in Indiana which has the heaviest travel on highways is Marion County, in which is the city of Indianapolis. As Highway Superintendent of Marion County the County Commissioners have just appointed a man who is now Assistant Superintendent of the County Infirmary at a salary of $55 a month, and whose previous experience on highway work consists of a short period as a road supervisor at $2 per day under one of the politicians who compose the Board of County Commissioners.

The Indianapolis "News" of Dec. 6 says:

It was understood that the County Highway Superintendent was to be a man equipped with scientific and practical knowledge of road maintenance. Reports to the effect that it would be difficult for the county commissioners to get a competent man for the place at $5 a day, the amount the superintendent will receive, led the division of the Chamber of Commerce, which is interested in good roads, to advertise for civil engineers who would be willing to take the place at the salary offered. The advertisement brought many replies. Investigation of the ability of the various applicants was then made and the report was submitted to the county commissioners. Some of the civil engineers who applied for the place had had large experience in railroad construction work and some had had experience which would have proved valuable in keeping roads in proper condition. Mr. James Kervan, president of the board of county commissioners, said the board decided that Marion County did not need a civil engineer for the position.

Federal vs. Private Irrigation

By D. C. Henny*

SYNOPSIS—Comparison is made between the cost of private and of government irrigation. Factors affecting the cost are analyzed. It is shown that cost of irrigation is far more dependent upon local conditions than upon the agency through which it is effected. Results as to settlement are presented and compared. The need of public funds for future irrigation development is explained. Some features of the Reclamation Act are discussed and desirable changes in the law are indicated.

The U. S. Government has for the last ten years been engaged in the reclamation of arid land on which it has expended $80,000,000 to date. The area actually irrigated in 1912 was 641,397 acres, and the area for which the Reclamation Service was prepared to supply water in 1912 was 1,193,374 acres.

It is not uncommon to hear opinions expressed to the effect that the government cannot carry on construction work as economically as private organizations. This charge has been made with frequency and persistence, at least in the West, regarding the work of the Reclamation Service.

In studying the underlying causes it is well to bear in mind the important difference between this and all other lines of government construction. The fact that it is the only government work of which the cost of construction and maintenance and operation is required to be repaid by the direct beneficiaries, goes far to explain the recurring comments on such cost, with attendant charges of extravagance.

The hope that by affecting public opinion Congress may be induced to ease off the repayment requirements of the present laws provides a peculiarly attractive object for reiteration.

An incident which happened recently illustrates this point. At a hearing in Washington granted a few months ago to representatives of settlers on the various government projects by the Secretary of the Interior, the men from the various Montana projects alleged that the settlers could not meet their obligations to the government. Aside from the usual charges of extravagance it was strongly urged that the quality of the land was poor and the climate was bad, and extension of time and reduction of charges were demanded. The claims were so strongly urged that a representative of Colorado settlers, anxious to have more money spent in his section, pointed out to the Secretary the wisdom of not expending any more funds in a state with so many drawbacks and requested a transfer of several million dollars for future expenditure from Montana to Colorado, where settlers would agree to meet all obligations. The writer happened to be in Montana at the time the above proceedings became known there and within a few days another group of Montana men proceeded to Washington, men prominent in the development of the state, including the governor, an ex-governor, the president of the State Agricultural College, successful farmers and representatives of transcontinental railroads. These men proceeded to show and to prove that previous testimony was untrue or one-sided and entered their protest against the diversion of funds.

Prosperous settlers on reclamation projects admit that the criticisms made have for their principal object a partial release, through easier terms or otherwise, from accepted obligations and are not generally disposed to go out of their way to offer evidence to the contrary, being naturally quite willing to share the benefits which may result from any agitation.

The above is not stated in any spirit on the part of the writer of lack of sympathy with the average settler and pioneer. He has a hard battle to fight under severe conditions. Such reasonable measures of relief as have been contemplated have the hearty approval of the writer. It is, however, desirable that the reason for the persistency of adverse comments be fully understood.

One of the favorite cries is that the water charges exacted by the government are higher than those prevailing with private companies or irrigation districts. In order to permit the forming of a rough judgment on this point, regardless of controlling considerations affecting cost, a tentative table was prepared by the Reclamation Service listing water charges of various private projects and giving acre cost figures of government projects (published in Eng. News, May 15, 1913). Inasmuch as this presentation has given rise to discussions by engineers, notably in an article by John E. Field (Eng. News., Aug. 21, 1913), it has seemed advisable to the writer to consider this subject in greater detail.

The personal point of view is often important, for which reason it may be stated that the writer had charge from 1905 to 1909 of the Pacific Division of the United States Reclamation Service as supervising engineer and that he continues to act as consulting engineer for the Reclamation Service, in which capacity he has become familiar with work on most of the government projects. Prior and subsequent to the period above mentioned he has been and is now connected as consulting engineer with various irrigation projects—Carey Act, district and private—and he believes he in in a position to make an impartial comparison.

Referring to the above mentioned discussions and tabulations of comparative acre-cost of irrigation, it may be safely inferred from the figures presented, after the introduction of whatever corrections appear necessary, that there are a number of district and private irrigation enterprises on which the acre charges are greater than on any of the government projects. Among the latter there are but two for which a construction charge of $60 per acre is exceeded (for both of which the writer happens to be largely responsible) and there is none with a charge higher than $100. Among the list of private Colorado projects alone there are eight for which the cost to users exceeds $60 and two where this charge is well over $100. This leaves out of consideration such states as

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California and Washington, where the higher value of lands has rendered high charges more than usually common. So far, therefore, as the occasionally expressed belief is concerned that government irrigation is *a priori* more expensive to water users than private irrigation, it is effectually refuted by the quoted tabulations.

Organization through which irrigation is effected is in itself not an overshadowing factor in the item of cost to irrigators. There is a very large range of charges on the projects of the Reclamation Service, varying from $22 to nearly $100 per acre. In the case of Carey Act enterprises there is also a considerable difference in charges, running in the State of Idaho alone from $25 to over $65 per acre. There is an even wider range with works built by irrigation districts. A rather interesting example is that afforded by a small section in the vicinity of Grand Junction, Colorado, where there are five district enterprises all pumping water to their lands.

The gross outstanding debt of these districts is shown in the following list:

	Debt.	Acres	Cost per acre
Palisade	$265,800	5880	$45
Mesa	205,000	2624	78
East Palisade	53,600	600	89
Orchard Mesa	1,329,480	8670	153
South Palisade Heights	110,600	615	180

It should be stated that while the acreages are taken from district statements required by law, it is possible that these may be subsequently somewhat increased by the inclusion of public lands, whereby the average resultant cost figures may be ultimately reduced.

Similar large differences exist in the charges of strictly private projects of which the Yakima Valley in Washington furnishes a good example, where water-rights per acre vary from less than $50 to $135 and over.

The wide variations in charges in each class make it plain that while the character of organization undoubtedly has some influence on water charges, its effect is obliterated by other and usually far more important considerations.

Irrigation along a stream follows lines of least resistance, proceeding from the easy and cheap to the difficult and expensive, pressing in its evolution against the upward moving line of values created. Increasing cost results both from long canals and from the insufficient amount of midsummer flow necessitating relatively increasing amounts of storage, counterbalanced to a small extent by the exercise of greater water economy.

Thus it may be said roughly that the cost of projects along a stream depend upon the relative period at which they were started and the one last constructed is generally found the most expensive.

Reclamation Service work has been carried on only since 1902 and it entered scarcely any locality where it did not find the most economical propositions well developed. In studying possibilities in various districts undeveloped opportunites were sometimes found, partially, however, preëmpted by private companies and the adopted policy of noninterference where other agencies than the government gave promise of extending irrigation, resulted in the consideration of other and more costly enterprises. These conditions naturally raise the cost of projects built by the Reclamation Service in comparison with older works, and this is largely true also of recent private as well as of public enterprises. For statistical comparison, if it is to yield any reliable results, the period of construction becomes of the utmost importance although somewhat affected by the opening up of new territory through the construction of railroads. Thus irrigation projects in Central Oregon have gained in attractiveness with the advance of railroads into that field.

As stated, the effect is felt not only in the necessity of building long and expensive canals but also in the construction of storage reservoirs which have become a prominent feature of cost of Reclamation projects as well as of recently built private projects. These storage reservoirs in themselves vary greatly in cost per acre-foot stored, and consequently per acre of land served. There are a few cases where the utilization of existing lakes has rendered it possible to store water at less than $1 per acre-foot of annual draft and while the average cost of government reservoirs is probably less than $10 per acre-foot, it rises in one instance to over $35 per acre-foot.

In comparisons sight is apt to be lost of the difference in the amount of supply provided. In the State of Washington there are many private companies which sell water-right contracts on the basis of a steady flow of 1 sec.-ft. per 160 acres. Such supply may be approximately sufficient as to seasonal amount, but the rate during midsummer is generally insufficient and the same is true of canal capacities based thereon, which in turn have a material effect on cost. It is believed that in general the capacity of canals and laterals has been treated with greater care and liberality in Reclamation Service work than has been the case with much private irrigation work carried on during recent years.

The character of construction is another feature of great importance. Charges against the Reclamation Service have been sometimes based on the alleged fact that works were too monumental in character. So far as the writer is aware the only principle which has been followed is that of lowest ultimate cost, considering that for a certain period investment is free from interest charges, which naturally resulted in more permanent construction and greater first cost. Nevertheless, it also is true that some of the work of the Service has been criticized for its boldness of construction and failure or partial failure was predicted, as for instance in the case of the Tieton Canal in the State of Washington and of the relatively steep slopes of the Belle Fourche Dam. The Pathfinder and Shoshone dams were, when built, the boldest structures of their magnitude in existence.

An item greatly affecting cost is the extent to which lateral systems are built. It was believed to have been the intention of the Reclamation Act for the government to construct the principal canals and also storage works where necessary, but to leave the building of lateral systems to the settlers. Anyone acquainted with the gradual settlement and irrigation of arid lands, who has seen numerous sublaterals paralleling each other for a long distance, with the attendant heavy operation expenses and seepage losses, who has noted settlers compelled to build several miles of lateral to reach their scattered parcels of land and who has observed the numerous right-of-way complications and neighborhood quarrels to which this gives rise, understands why such partial construction, though still frequently followed by private companies, is not wise. Hence, the gradual addition to government work of constructing laterals and sublaterals. In one

instance the addition of a sublateral system reaching each farm unit instead of each quarter section caused the addition of $17 per acre of total project cost and was entered upon only at the earnest request of the Water Users' Association.

Another important item of cost has been, in some cases, the necessity of drainage. This is not usually regarded on private irrigation enterprises as part of the cost of irrigation work. The fact that higher lands contribute to the drainage of low lands has gradually led to the consideration that the latter should not be solely made to suffer for their disadvantage of position. Moreover, such lands when ruined have been frequently abandoned and will in such case no longer contribute either to the first cost or to the maintenance and operation of the irrigation system. Thus, there has developed a tendency where work is done under government auspices, both in this country and elsewhere, to consider drainage a necessary part of a complete irrigation system, and this tendency has found expression in the work and cost of some of the Reclamation projects.

The writer has occasionally recommended to private companies the inclusion of cost of drainage in irrigation charges, but while this is now possibly being done in exceptional cases of recent construction, he is not familiar with any case in private irrigation enterprises where this has been accepted as the proper principle. In private work the remedy has generally been to resort to drainage district laws, permitting water-logged portions of irrigated localities to tax themselves for the building of drainage canals and a large number of such drainage district works have been built and are maintained, independent of irrigation organization.

There are numerous other factors having an important bearing on cost, such as climate, accessibility, local availability of building materials, etc., which affect private and government work alike and which partly account for the wide differences in water charges.

There is one factor which adds greatly to the comparative cost of government work: the eight-hour labor law. Its interpretation as regards contract work was at first uncertain but decisions were soon rendered making the law applicable to all labor employed on government work. Common labor demands but little if any more for ten than for eight hours work at points far removed from cities, and as a result the cost item due to labor, which is usually relatively large on irrigation construction, is thus approximately 20% greater than for private work.

It has been frequently stated that overhead charges in the case of government work are excessive, but no proofs have been offered. If any large corporation handled from New York adds less to cost for financing, legal work and general oversight than is added by the Reclamation Service for its Washington office, performing somewhat similar functions, the writer has to learn of such instances. In both cases the addition is legitimate and unavoidable.

Overhead expenses result from a desire to economize and within certain limits their absence should arouse suspicion. No important engineering enterprise is at present being carried on without the advice of consulting experts, and this is secured merely to avoid expensive mistakes and to study the introduction of economy.

The writer recently made an investigation of a Carey Act enterprise in Wyoming. The books showed that the cost for engineering for the period during which over $1,000,000 was expended had amounted to $13,000. This may seem an enviable showing but the facts on the ground do not support such a conclusion and largely are a result of an insufficient grasp of the engineering features the company is now in the hands of a receiver.

Proper judgment of the legitimacy and economy of overhead expenses requires critical study and offhand opinions on this subject are both unwarranted and dangerous.

It has been claimed that government work is expensive because contractors bid high, despairing of obtaining fair treatment from the engineers. It is true that engineers in charge of public work, whether federal, state or municipal, do not assume the freedom frequently exercised by engineers for private works with the full approval of controlling directors to ignore specifications in order to help contractors. Whether contractors bid on the one hand more or less hastily, on the basis of expecting relief, when things go against them, or on the other hand use more care, understanding that no such relief can be legally granted, the ultimate result as to cost probably does not differ widely on this account. The charge of sandpapering being required on the part of the government engineers is too silly to require refutation, other than by pointing to the works themselves as built.

A charge which is frequently made against government work is that it is badly hampered by red tape. That term presumably implies excess of binding regulations intended originally to facilitate distant control and to insure compliance with the laws. The writer is not familiar with other government operations but speaks from experience when he states that in Reclamation work it has been found feasible to introduce so many short cuts and sweep away such a variety of obsolete requirements that he believes there is as much directness in its administration as in any large private organization, and an equal concentration of authority. Moreover, as is well known, the Service has been kept completely free from politics. The charge which Mr. Field makes that the government is considered a legitimate source of ready money and easy work may be based upon his own experience but is, so far as its application to Reclamation Service work generally is concerned, utterly unfounded on facts, nor has any proof been brought forward.

A large amount of construction work is being done by the Service by day labor and from frequent comparison the writer concludes that as regards organization and performance the work of the Service is as well managed as the better class of private work and better than ordinary contract work.

The cost of government projects includes a comparatively large allowance for preliminary investigations. The thorough consideration in advance of all the essentials bearing on any project to be undertaken is believed to be the best available insurance for avoiding failures and tends toward the highest economy. Large companies who have funds available act upon the same principle. Many of the failures of irrigation undertakings have been due to lack of sufficient funds or time for examination or of appreciation of necessity therefor.

Many complaints have been made by the settlers that the original estimates have been greatly exceeded. Under

the law the estimated cost is to be paid back by the water users and there is no one but the Secretary of the Interior who has authority to announce such estimated cost. Landowners, during the early stages of the work, have naturally been anxious to know what this cost might be per acre and under pressure of constant inquiry some engineers in the Service may have given out preliminary figures, accompanied by qualifications as to possible increase, and when these were subsequently exceeded by the estimated figures, as announced by the Secretary, protests arose and it was claimed that earlier figures must stand in spite of whatever qualifications accompanied their presentation.

It is a fact that many of the early preliminary estimates have been exceeded and that in the opening up of successive units of a project, or in redrafting contracts with water users' associations, there has been a necessity for increasing estimated cost figures.

The principal cause for increase in cost must be found in the rise of wages of all labor and the decrease in efficiency since 1902, '03 and '04, during which the majority of present projects were estimated and approved. This is a fact well known to every Western engineer and while private companies do not generally confide their financial troubles to the public, there is at least one well known railroad president who stated that construction estimates made during the years just mentioned have been exceeded by an average of 60%. Note in this connection the statement of Mr. Mondell, the congressman for Wyoming (quoted in ENG. NEWS, May 15, 1913, p. 1008), that prices of common labor in the West advanced 20 to 50% in the period from 1903 to 1911 and that the efficiency of such labor fell off in greater proportion. Prices of material also have shown an upward tendency, far less acute, however, and of much smaller influence in cost of irrigation work.

The tendency of including small laterals and sublaterals in the work to be constructed to an extent greater than had been contemplated and the changing policy of providing to some extent for drainage works have had an important effect on ultimate cost.

It is quite likely that in some cases contingencies other than possible rise in prices were not sufficiently foreseen. Many sections where work was done are not only remote but there is little local knowledge regarding the behavior of floods, climatic interference, etc., which in Eastern states are generally matters of common knowledge. Most of these factors have contributed to increase the cost on private as well as government work, and many are the private irrigation enterprises which have suffered in consequence, some of them being left in a disastrous state of incompletion.

It may be said in this connection that with an advance in the cost of labor and material there has gone hand in hand a rise in prices of farm lands which has tended to maintain stability in the relations between cost and values created.

All of the above refers to construction cost. Regarding the equally important matter of maintenance and operation charges it may be said that while the permanent character of construction affects such charges favorably, the reasons for relatively high construction cost due to long canals and necessity for storage operate toward an increase.

Systematic measurement and division of water as carried on by the Reclamation Service is rarely equaled in the operation of private works. It is essential for intelligent management, as it insures equality of service to water users and indicates where water waste may be prevented. While the maintenance and operation account of private companies may be reported as low in certain cases, such small cost is often due in part to insufficiency of water control, with its resultant injustice and damage to water users at the tail end of the canals during the height of the irrigation season.

The statement is made by Mr. Field that the average cost of maintenance and operation on Reclamation projects was $1.88 per acre for 1911 and he argues from this figure as to the gross cost by capitalizing annual expenses and adding the result to construction cost for general comparison. The eleventh annual report of the Service, from which the above figure is abstracted, shows it to be the average cost per acre "actually irrigated." The systems operated, however, while actually irrigating 564,696 acres are also shown to have been ready to serve 1,015,494 acres, the difference being made up mainly by private lands whose owners have failed to use the water and by public land not yet entered. Annual charges are accumulating against both kinds of lands and these back charges are collected as the vacancies are being filled. To determine comparative cost it is plainly wrong to divide the cost over the smaller area. If this were done for the more recently built private projects, which are only partially settled, the results would be prohibitive in many cases within the knowledge of the writer. On the basis of area for which the Service was prepared to supply water, the cost of maintenance and operation during 1911 was $1,058,238 for 1,015,494 acres, or $1.04 per acre instead of $1.88. This figure is gradually being reduced as canal banks are becoming settled and breaks become more rare. As it is, it falls below the average annual cost of maintenance and operation for all states and character of projects for the year 1909, which, according to the Thirteenth U. S. Census Report, was $1.07.

The above comparison does not and cannot bring out clearly the additional item of depreciation, which for government construction will be admitted to be relatively lower than is the case with the average privately built works.

Take as an instance one of the district works on the Grand River in Colorado, previously mentioned, the Orchard Mesa district. Maintenance and operation for 1914 is estimated at $22,000, amounting, for the 8670 acres on which the assessment is laid, to over $2.50 per acre. The total assessment for 1914 is required to produce $10,000 for previous deficiencies and $64,500 for interest on bond indebtedness, making an aggregate of $96,500 or over $11 per acre for the coming year. These figures, however, make no allowance for the depreciation of the long line of wooden flume constituting a large portion of the canal, which will make itself definitely felt in the course of a few years.

This case is mentioned because so far as the use of wooden flume is concerned it is a type of private irrigation construction, perfectly legitimate and quite common, where interest charges have to be met from the beginning. It often explains low construction cost, although not in this instance, which is, as previously shown, more costly than any of the Reclamation Service

projects, even those developing their own power for pumping.

As regards engineering design and execution it must be remembered that the advance of engineering knowledge becomes quickly the property of all. Reclamation engineers were originally drafted largely from private practice and many have returned to it. It is preposterous to assert that with the constant exchange of engineers and construction superintendents and of engineering knowledge there should be a definite line of demarcation and that the work of one set of engineers should be decidedly better or worse, economic conditions being taken into account, than that of another set. And this applies equally to the devotedness of the men to their work whether in government employ or not. If there is any fundamental difference in the results as to cost it is due to such causes as have been pointed out, which operate partly in favor of one method of construction and partly in favor of another. If any conclusion is warranted it might be this: that the eight-hour law increases all charges, that higher class of construction increases cost and reduces maintenance and operation charges especially in the long run and that, on the whole cost charges would normally be relatively high on government projects if private enterprise could dispense with the necessity of charging interest and profit. This latter consideration is apt to completely reverse the situation, and this applies partly also to irrigation districts, whose directors are generally confronted with the necessity in one form or another of paying heavy charges for financing.

The Reclamation Service has on the one hand been criticized for allowing settlers to wait indefinitely for water, on the other for preparing more land for irrigation than can be absorbed. The latter charge may have some merit in it, at least the figures seem to go far to support it, as is shown in the following schedule for 1911 and 1912.

	Land ready to be served acres	Land actually irrigated acres	Per cent.
1911	1,015,494	564,681	56
1912	1,193,374	641,397	57

The areas not as yet using water are largely private lands, much of which is held at higher figures than actual farmers are willing to pay.

In judging this showing it should be borne in mind that the area of land ready to be served is steadily on the increase and that the percentage actually irrigated would grow rapidly if further expansion of construction were to stop. This, however, is neither desired by the communities most directly affected nor considered good policy on the part of the Interior Department.

It is interesting to compare the above showing with that indicated by other methods of irrigation expansion. The Carey Act has been utilized for irrigation development to a greater and more legitimate extent in Idaho than in any other state. From the report of Mr. A. E. Robinson, the State Engineer, it appears that there were in that state up to Nov. 1, 1912, 26 Carey Act enterprises with a total segregation of 1,148,449 acres.

Many of these projects are as yet in a state of incompletion. Selection has been made of those which are practically complete, and it is probable that this selection has eliminated some of the less successful enterprises. The report states the acreage for which patent has been applied but does not show the area of private lands included in each project. This area is presumed to be relatively small and for the purpose in hand has been ignored except in the cases where the area irrigated exceeds that for which patent is applied. The result is shown in the following table:

Name of company	Acreage applied for patent	Acreage irrigated during 1912	Canal completed before ginning of 1912 season
Am. Falls C. & P. Co.	56,158	20,000	100
Grand View L. & I. Co.	1,000	500	100
High Line Pump. Co.	5,000	1,200	100
Marysville C. & Imp. Co.	10,400a	10,400	98
Idaho Irr. Co., Ltd.	119,717	22,000	95
Twin Falls Land & Water Co.	212,158	170,000	100
Twin Falls N. Side Land & Water Co.	161,122	41,000	90
Twin Falls-Salmon L. Land & Water Co.	92,707b	19,000	99
	658,262	284,100	

(a) This amount is assumed as equal to acreage irrigated, the acreage for which patent was applied being given as 7002 acres.
(b) Difference between area for which patent was applied and area for which relinquishment was filed.

It will be noted that the acreage irrigated amounts to 43% of that covered by canals, as against 57% in the case of government projects.

While little is heard generally of complaints from settlers on Carey Act projects, the respective state land boards handling these matters have their hands full and the companies who have built the works under contracts with the state are face to face with difficulties at least as serious as any experienced by the Reclamation Service.

There yet remains to be considered the more serious allegation, that settlers are unable to pay the charges assessed by the government. Here truly a vital point is touched in all irrigation enterprise. It is a difficulty which seriously faces private and public enterprises alike.

The immediate question is not so much whether industrious settlers with a sufficiency of funds to tide them over the first few years required to make their land productive will ultimately make adequate profits in return for their efforts and outlay. There are very few instances where this question cannot be answered in the affirmative and by this test most irrigation enterprises would be pronounced eminently successful. The more pressing problem is how to eliminate speculators and how to secure settlers of the above type. This is particularly true as to Reclamation Service projects which have been often supposed to furnish a means of providing homes indiscriminately for the poor and which have given rise to rapid advances of land values attracting land speculators.

Pioneer conditions on newly irrigated desert lands are not attractive to people of means and so far as men of small means honestly face the battle before them, they deserve the utmost credit and all the assistance which can be rendered them. These men are recognized as a distinct asset in any irrigating community and private companies frequently make it a policy to extend to them financial assistance so far as it is within their power. Likewise they are an asset in Reclamation Service projects and everything has been done to assist them within the discretionary limits of the power of the Secretary of the Interior.

Whether or not the *bona fide* cultivators can make the earlier payments is an open question. But it is hardly open to doubt that from an economic standpoint it is better that for a time any funds they may have available should be turned into the soil and into the improvement of their living conditions rather than that the govern-

ment should have the earlier use of such funds for further investment. The Reclamation Act in its requirements for repayment does not sufficiently recognize these facts, and it is desirable that they be fully considered by Congress.

If under a more liberal policy of repayment returning funds are inadequate for a wise expansion of government irrigation, other means for raising funds can undoubtedly be found. It will be essential, however, in order to eliminate land speculation as far as possible, to make cumulative cultivation a prior condition to any departure from present requirements. With such cultivation, and with a payment at the time of filing water application, water charges of all kind during the first few years might be omitted and subsequent payments might be fixed for each project on the basis of a graduated schedule, spread over a greater number of years and continuing until all cost is paid.

It would also be advantageous for the Secretary of the Interior to be able to utilize the irrigation district for the control and management of large units of Reclamation projects and for the collection of charges. Local management would thus be secured at the earliest date, owners of land left idle would be made to bear a just part of the general burden of development and all land would be more quickly forced into use.

Removal of the residence clause has been frequently demanded by owners of private lands under Reclamation projects. There is some reason to comply with this demand if cumulative cultivation is exacted in place of residence.

With such changes in the law it is quite certain that the practical success of Reclamation projects will be greatly expedited. Early and undisputed success is deemed the more important by reason of the constantly increasing acre cost of irrigation works in the United States and the growing necessity for the use of public funds for their construction, if irrigation is to continue to expand.

Foreign Ladder Dredges

An interesting feature in regard to dredging work is the difference in the types of machinery employed in the United States and in other countries. In this country the dipper dredge is employed very extensively, being built in large and small sizes and used on a variety of works, while the ladder dredge is practically unknown. In most other countries, however, the ladder dredge is a common machine and the dipper dredge is practically unknown. The suction or hydraulic dredge is used very extensively both in this country and abroad.

This question of the difference in American and foreign practice as to ladder and dipper dredges was discussed in ENGINEERING NEWS some years ago,* more particularly with regard to harbor dredging. In reviewing the reasons for this difference, A. W. Robinson, an engineer specializing in dredging machinery, stated that in foreign countries the harbors are in charge of boards or commissions which own their dredging plant and can afford the heavier first cost of a ladder dredge for permanent work. An American contractor would not want to make so large an investment, and would need a machine adapted for work of varying character.

He considered the dipper dredge to be the better, as an all-round machine, while it is simple in design and of relatively low cost. It is essentially an American invention, and its extensive use has led to its development and improvement as a highly efficient machine. On the other hand, the ladder dredge has been improved also, especially in the reduction of repair and operating costs. The same views were expressed by him in a paper on "Dredges" presented at the International Engineering Congress, at St. Louis, in 1904. About two years ago a large dipper dredge designed by Mr. Robinson was put in service on the upper Nile, in Egypt, and this is one of the very few foreign dredges of this type.

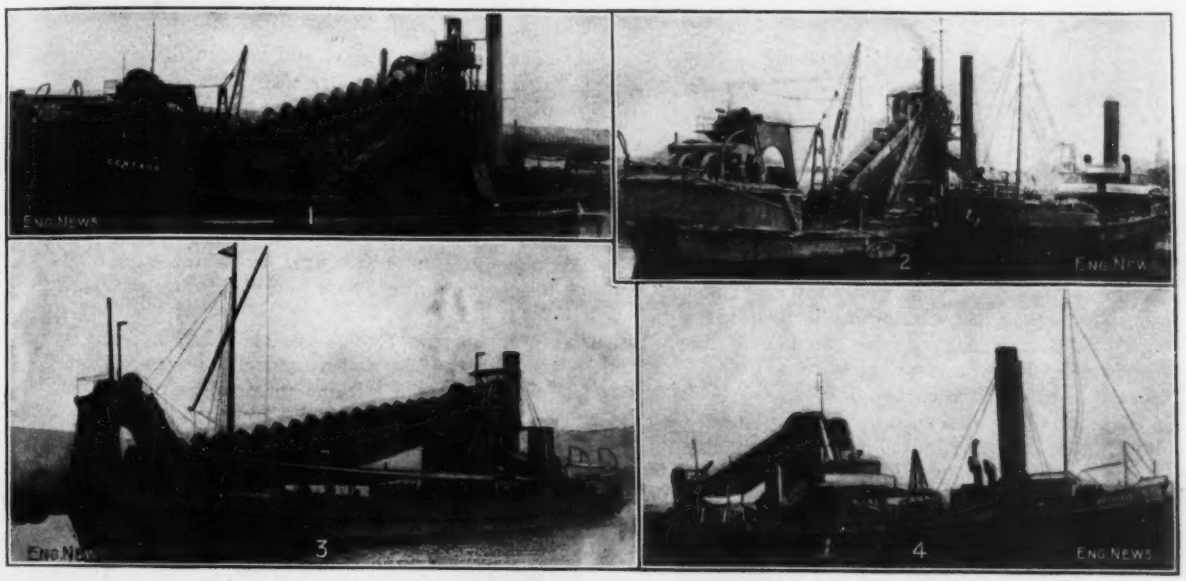


FIG. 1. FOREIGN LADDER DREDGES OF THE BARGE-LOADING TYPE

1. Dredge "Centaur" for Liverpool; Mersey Docks and Harbor Board.
2. Dredge on the Clyde, at Glasgow, delivering to a hopper-barge steamer.
3. Dredge "Affonso Penna," for South America.
4. Dredge "Hsin Ho" for Tientsin; Chinese Government.

*"Engineering News," 1896, I, 181, 187, 236, 291.

The use of ladder dredges in this country is limited almost exclusively to the dredging of gold-bearing gravel, where the service is continuous and the conditions are permanent. Among the few exceptional cases of the use of ladder dredges for general excavation may be noted the very large English-built dredge "Corozal" for the Panama Canal.* This is a bow-well hopper dredge with a capacity of 1200 cu.yd. per hr., a hopper capacity of 1200 tons, and a speed of 10 m.p.h. with hoppers loaded. A ladder dredge was employed several years ago for filling trestles over swamp lands on the New Orleans & Northeastern Ry. Two machines of this class were used on a part of the New York barge canal in 1907, but were said to have proved too light for the work.

More recently a ladder dredge has been used on the 35-ft. channel in Boston Harbor, where the working

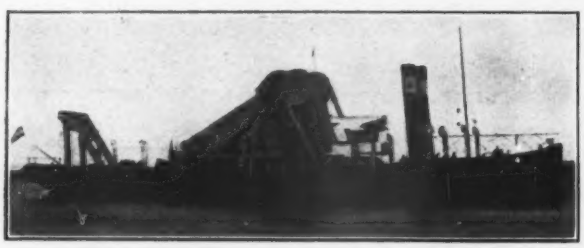


FIG. 2. COMBINED LADDER AND SUCTION DREDGE, WITH SHORE DELIVERY PUMP, FOR THE HARBOR OF BUENOS AIRES, ARGENTINE REPUBLIC

depth is about 50 ft. at high water. The contractors considered that the work could be handled more effectively with a ladder dredge than with their dipper dredges. They, therefore, took an old wooden steamer that had seen service on the Great Lakes, and converted it into a ladder dredge, capable of working to a depth of 52 ft. The machine had 1¼-yd. buckets and could dredge 1000 cu.yd. per hr., delivering the material to barges. It was found that this vessel could work in rougher weather than dipper dredges on the some work, while the loss of working time and the cost of operation and repair were less than with the latter machines.†

Ladder dredges may be classed as hopper and barge-loading dredges, the former carrying the material and transporting it to the depositing grounds. They may be classed also as bow-well and stern-well machines, dredging at the bow and stern respectively. Some of the machines are equipped also with dredging pumps, either for use as suction dredges or for unloading dredged material from the hoppers or from barges and pumping it ashore.

Fig. 1 shows four barge-loading ladder dredges. The first is the "Centaur," one of the numerous large dredges employed by the Mersey Docks & Harbor Board, of Liverpool, in maintaining the deep-water ship channels at the entrance of the river Mersey. This is of the bow-well type, and has a capacity for dredging 1000 tons per hr. from a depth of 56 ft. The second is a very similar machine in the service of the Clyde Navigation Trustees, of Glasgow, and in this case the dredge is shown delivering the material to a self-propelling hopper barge of 1250 tons capacity. A somewhat smaller machine for the Tees Conservancy Commission, with a capacity for dredging 700 tons from a depth of 38 ft. in the open river, is specially designed to enable it to dredge to a depth of 30 ft. close up to the dock walls. This is 136 ft. long, 30 ft. and 10½ ft. deep.

The third vessel is the "Affonso Penna," a sea-going dredge for a South American port, and it will be noticed that the bow-well is closed while the vessel is navigating. This can dredge 800 cu.yd. per hr. to a depth of 43 ft., and the gearing provides for driving the buckets at two speeds, to suit the varying character of the material. The three machines mentioned were built by Fleming & Ferguson, of Paisley, Scotland.

The fourth dredge, in Fig. 1, is the twin-screw "Hsin-Ho" for the service of the Chinese Government at Tientsin. It is of the stern-well type, and is fitted also with a centrifugal pump and suction pipes for use as a hydraulic dredge or for pumping the spoil delivered from the buckets. In the latter case, one of the main propelling engines drives the ladder chain and the other drives the pump. The material from the buckets is passed through a revolving cutter which cuts up the large masses (assisted by a high-pressure water jet) and removes large stones which might injure the pump. With lighter material, both the bucket and suction dredge can be operated together, being driven by one of the main engines, while the other engine drives the force or delivery pump, as before. This vessel is 158 ft. long, 37 ft. beam, 11½ ft. deep, with a working draft of 6½ ft. and a speed of 8 m.p.h., while the dredging capacity is 650 cu.yd. per hr. at a depth of 26 ft. (ladder angle 45°). The two main engines are of 320 hp. each. The ladder chain runs at about 140 r.p.m., or at the rate of 14 to 16 buckets per min., each bucket having a capacity of 21 cu.ft.

A machine of the same class for dredging very stiff clay at Adelaide, South Australia, has an extremely rigid and heavy ladder frame to stand up against the heavy cutting, and is driven by a compound engine of 500 hp. which works either the screw or the dredging gear. The ladder chain passes over tumblers 16 ft. diameter and carries buckets of 21-cu.ft. capacity. The nominal capacity is 500 cu.yd. per hr. at a maximum depth of 43 ft. but it has dredged as much as 630 yd. per hr. The "Adelaide" and the "Hsin Ho" (Fig. 1) were built by A. F. Smulders, Schiedam, Holland.

Fig. 2 shows a large sea-going combined ladder and suction dredge built by the Werf Conrad, of Haarlem, Holland, for the Ministry of Public Works of the Argentine Republic, the machine being for dredging in the harbor of Buenos Aires. This is of the stern-well type, with a very heavy gallows frame for the ladder suspension. Its shore delivery pipe extends through the bow of the hull. This vessel is 200 ft. long, 36 ft. beam, 16½ ft. deep, with a working draft of 11½ ft. It can dredge to a depth of 43 ft. with the buckets, or 53 ft. with the suction pipe, and has a dredging capacity of 850 yd. per hr., while it can deliver the material through 2300 ft. of pipe. The engines are of 1350 hp. Very similar machines have been built by the same firm for the contractors for dredging in the harbor of Dakar (Africa); also for the Russian Ministry of Ways and Communication. These last are for river-improvement work and are shallow-draft stern-wheel bow-well vessels 140 ft. long, with engines of 2000 hp.

Fig. 3 shows two large stern-well ladder dredges of the hopper type, which deliver the material to the hopper-bottom hull and transport it to the dumping point. The

*"Engineering News," Jan. 25, 1912.
†"Engineering News," Jan. 27, 1910.

upper one is a twin-screw stern-well dredge, the "Teredo," for the South African government, intended for work in the harbor of Durban (Natal). It has a hopper capacity of 800 tons or 600 cu.yd., and a dredging capacity of 1000 tons or 820 cu.yd. per hr., at a maximum depth of 40 ft. The lower view shows a similar

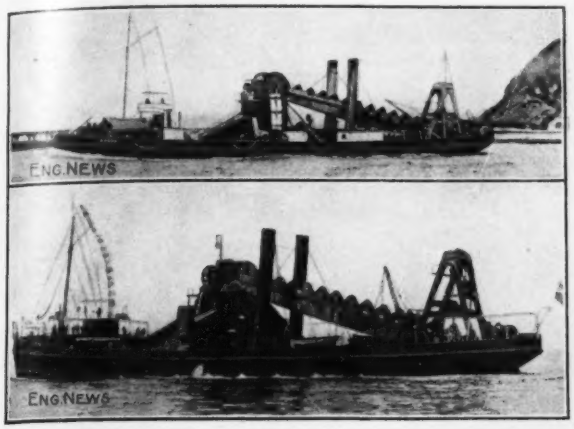


FIG. 3. TWO LARGE LADDER DREDGES OF THE HOPPER TYPE

A. Dredge "Teredo," for the harbor at Durban, Natal, South Africa.
B. Dredge "La Puissante," for the Suez Canal.

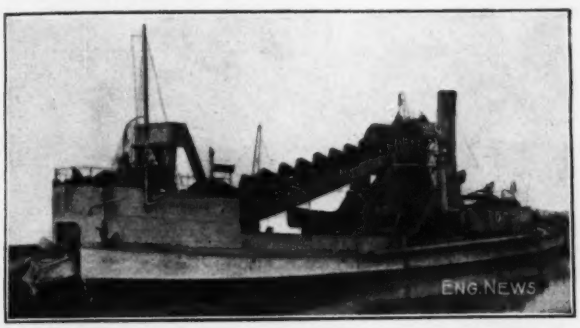


FIG. 4. COMBINED LADDER AND SUCTION DREDGE OF THE HOPPER TYPE, FOR NEW ZEALAND

but larger vessel, the "La Puissante" for the Suez Canal. This has a hopper capacity of 2000 tons and a dredging capacity of 1800 tons per hour.

Fig. 4 shows a hopper dredge of the combined ladder and suction types, with a bow-well ladder arrangement. This is the "Murihiku" for the New Zealand government, for work at Bluff Harbor. It has a dredging capacity of 530 tons per hr. (by either method), with a working depth of 34 ft., and has a hopper capacity of 450 tons. The suction pipe can be used either for dredging, or to discharge the material from the hoppers, the latter method being employed on land-reclamation work.

Finally, in Fig. 5 is shown a ladder hopper dredge of the smaller class. This is the "Slaney," for the Harbor Commissioners of Wexford, Ireland. It is of the bow-well type, with outboard suspension for the ladder frame. It can dredge to a depth of 25 ft., and has a dredging capacity of 250 tons per hr., with a hopper of 250 tons capacity. The dredges shown in Figs. 3, 4 and 5 were all built by Wm. Simons & Co., of Renfrew, Scotland.

Another type of dredge which is extensively used abroad is the grab-bucket dredge, which is generally of the hopper type. This has on the deck one or more revolving jib cranes handling grab buckets of form suitable to the material to be handled. A large dredge of this class has been built by Fleming & Ferguson, of Paisley, Scotland, for the London & Northwestern Ry., for

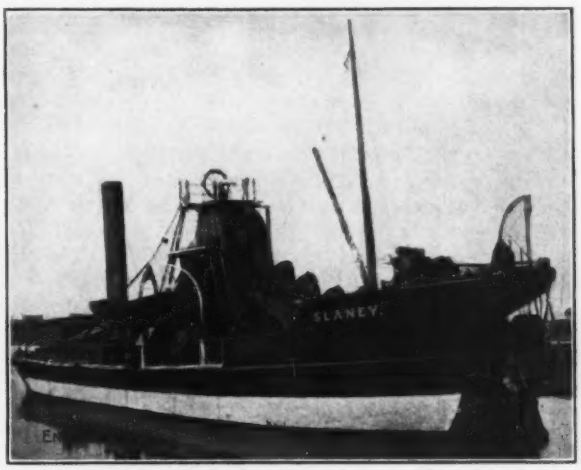


FIG. 5. SMALL LADDER DREDGE OF THE HOPPER TYPE FOR USE AT WEXFORD, IRELAND

use at its docks. It is 200 ft. long, with a hopper capacity of 1000 tons, and four grab-bucket cranes which give a dredging capacity of 600 tons per hr.

⁂

An Essay on Street Paving by Edgar Allan Poe—Most of us think of Edgar Allan Poe as the originator of the modern detective story and similar works of imagination and mystery and as the author of "The Raven"; but a copy of a brief article written by him for the "Broadway Journal" (New York City), about 1840, on "Street Paving" indicates that he was fairly well informed on at least one branch of civil engineering.

This article has been resurrected and sent to us by R. A. Millet, of the Solomon-Norcross Co., Engineers, Atlanta, Ga., after reading the letter on wood-block paving written in England in 1841, reprinted in our issue of Nov. 27, 1913, p. 1076.

The opening sentences quoted below are of interest as indicating current practice in street paving at that day when macadam and stone-block pavements were about the only types in use. Asphalt pavements were not introduced in this country until more than a quarter of a century later, in 1867; the first vitrified-brick pavement was laid in 1870, and the first portland-cement concrete in 1884.

Poe wrote:

> There is, perhaps, no point in the history of the useful arts more remarkable than the fact, that during the last two thousand years, the world has been able to make no essential improvements in road making. It may well be questioned of the Gothamites of 3845 will distinguish any traces of our Third Avenue—and in the matter of street pavement, properly so called, although of late, universal attention has been directed to the subject, and experiment after experiment has been tried, exhausting the ingenuity of all modern engineers, it appears that we have at last settled on a result which differs in no material degree, and in principle not at all, from that which the Romans attained, as if instinctively, in the Via Appia, the Via Flaminia, the Via Valeria, the Via Tusculana, and others. There are streets, in Pompeii today constructed on the very principle which is considered best by the moderns; or if there be any special variation, it certainly is not to the credit of modern ingenuity.

Poe then goes on to describe the Roman pavements in some detail, winding up with the conclusion that the stone-block pavements of New York City (which at that time were doubtless chiefly cobble) were but a poor and cheap imitation of the old Roman roads.

The remainder of the essay treats of the advantage of wood pavements and proposes the treatment of wood-paving blocks by the kyanizing process, which he describes in accurate scientific terms, although he says he is writing with no reference books before him.

New Pumps for the New Orleans Drainage System

The continued development of the surface-water drainage system of the City of New Orleans has made necessary a notable addition to the pumping equipment. Plans have been completed and bids for much of the work contemplated have been asked.

GENERAL DRAINAGE SYSTEM—The studies of the advisory engineers, Messrs. Harrod, Richardson and Hering, as reported in ENGINEERING NEWS, Mar. 15, 1900, showed that it was necessary to provide for (1) an aggregate annual rainfall of 64 in.; (2) a maximum fall of 3 in. per hr., and (3) a rate of 6 in. per hr. for 10 min. The whole design of these works was under peculiar adverse conditions as no gravity outfall was possible, on account of the large, flat and low-lying territory, and all precipitation would have to be pumped. There were seen to be three available outfalls: (1) The Mississippi River; (2) Lake Borgne, and (3) Lake Pontchartrain. The river, though conveniently located, was never considered on account of additional lift and the fact that the river could be entered only through immense lines of pressure pipe running uphill from pumping stations two or three miles away. Lake Pontchartrain lies at the doors of the city, being only some four miles from the center; Lake Borgne is virtually a bay of the Gulf of Mexico, to which Lake Pontchartrain connects, and is some 12 miles from the city limits. The level of each lake is the same and both are subject to the gulf tides which fluctuate with the winds, through a range of nearly 5 ft. It was desirable to avoid the pollution of Lake Pontchartrain as much as possible; yet the number of lifts needed in the long outfall canal to Lake Borgne led the Advisory Engineers to modify their original intention of sending the main flow here. They provided instead a limited flow to Lake Borgne, sufficient for dry weather and small-storm discharge and for the initial flow and final scouring of canals and drains; but the great volume from all storms of magnitude were to be led to Lake Pontchartrain.

The work was carried out as outlined by the Advisory Engineers and of about the full capacity. The total precipitation for 1912 was 74.68 in.—greater than the eighteen years' records of the Sewage & Water Board, and 20.6 higher than the average to 1912. But the recent returning cycle of rainfall is only a repetition of former experience fully appreciated by the Advisory Board of Engineers. The records show:

61.8 in. in 1895
69.1 in. in 1900
74.5 in. in 1905
64.2 in. in 1907
66.0 in. in 1909
62.7 in. in 1911
74.7 in. in 1912

The higher rainfalls, however, have been caused by brief storms of unusual intensity. In 1912, there were

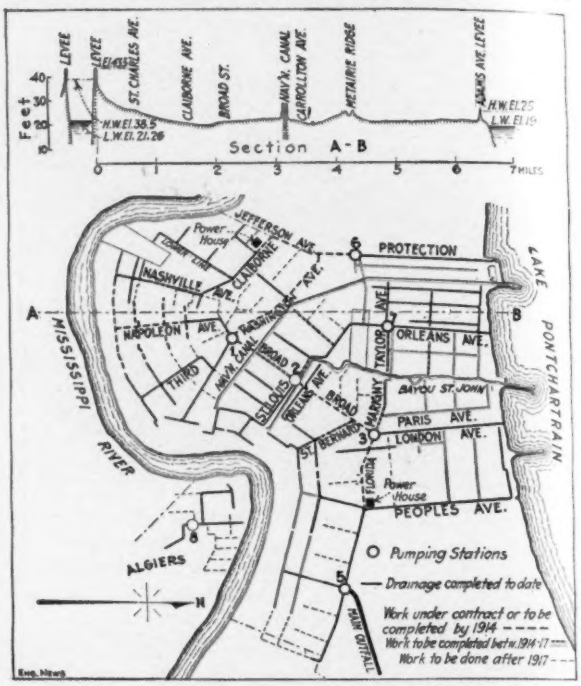


FIG. 1. MAP OF THE NEW ORLEANS DRAINAGE SYSTEM

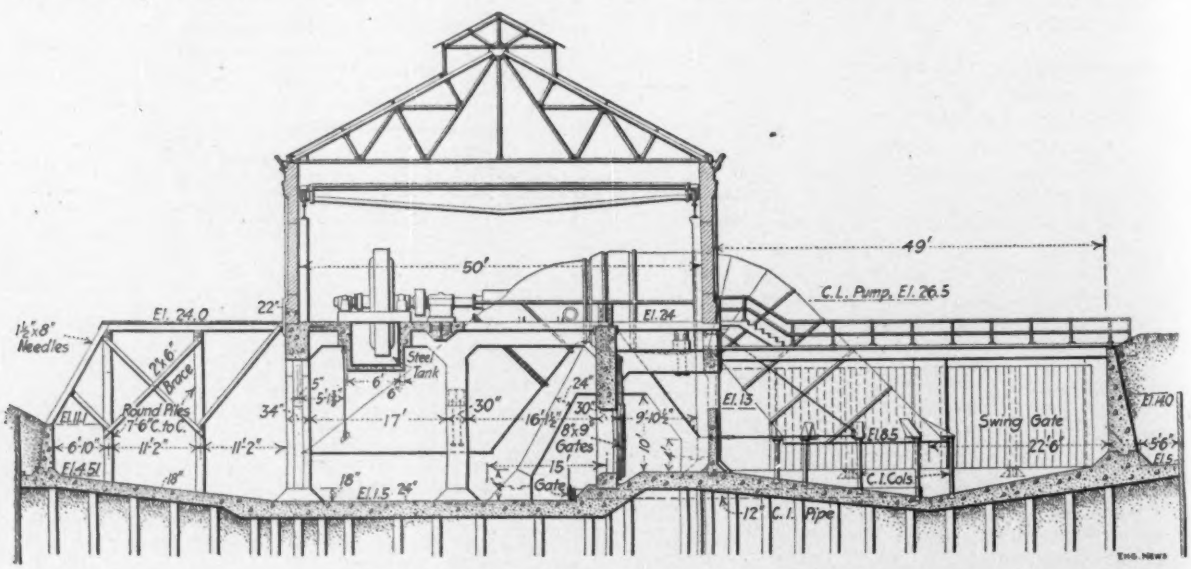


FIG. 2. PLAN OF ADDITION TO STATION NO. 1

seven storms ranging from 1.03 to 2.56 in. in one hour, and one storm giving 4.66 in. in two hours with 5.25 in. in 2 hr. 16 min. There was one storm giving 1 in. per hr. for nearly six hours, with a total of 6.55 in.

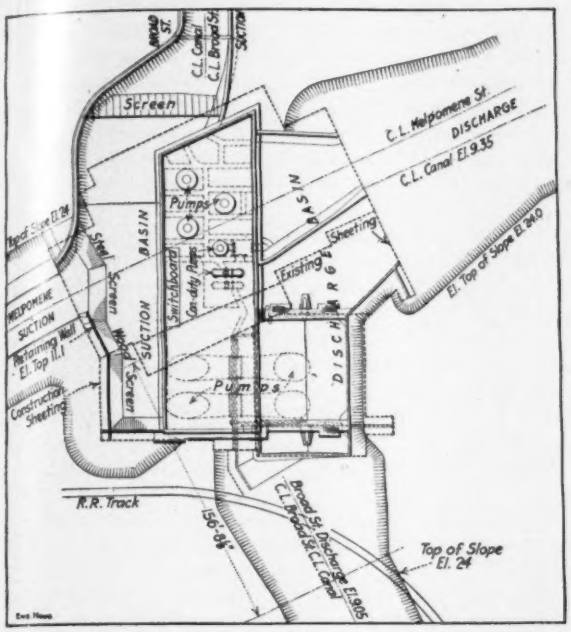


FIG. 3. SECTION THROUGH ADDITION TO STATION NO. 1

The canals were constructed for conditions wisely predicted at the beginning by the Advisory Board of Engineers. The report of these Advisory Engineers, mentioned before, started the improvement and still, 18 years later, is used as a guide without necessity for adding, deducting or apologizing for anything contained in it. In this way it is considered a remarkable document.

The pumping capacity first provided was restricted by funds then available, being designed to take care of ordinary storms, but known and stated to be below that required for occasional great downpours. The pumping plants are now being enlarged to fit the canal capacity, but even so it has not been attempted to prevent water from rising above the curb line of sidewalks at all times. With 25,000 acres subject to rainfall that may average 1 in. per hr. for six or eight hours, or with a runoff approaching 25,000 cu.ft. per sec. and requiring two or four lifts, this would have been impractical. With the added equipment all streets will be in about the condition seen in most other cities, having natural gravity, drains during such downpours. Probably few cities have to provide for such a rate of runoff per acre as in the thickly settled parts of New Orleans.

The pumping equipment, put into operation in 1900 with the improved canal system, gave a second-foot capacity three times that of the replaced system and against a much higher lift; it therefore provided drainage to a depth that gave reservoir capacity in the new canals and chance for the ground to dry out. As it was capable of taking care of everything but exceptional storms, the sanitary and commercial benefit were almost as great as with the added pumping capacity. This was shown in the drop in death rate of over 5 in 1000 which came when the system went into service. It now will be a question of relative canal and pump capacity whether a given locality will have water above the curb for a little while once in a few months, or once a year, once in five years, or once in ten years. It is a local question of relative value whether it is better to invest money to prevent occasional temporary inconvenience or to put it into other improvements of continuous public benefit.

The main system with its 50 miles of main low-level drains, 15 miles of leveled outfall canals and seven large pumping stations is shown in Fig. 1. The city is 7 to 14 ft. higher along the river front and slopes gradually toward Lake Pontchartrain until it reaches gulf level a mile or more back. The land continues practically level all the rest of the way to the lake except for a narrow

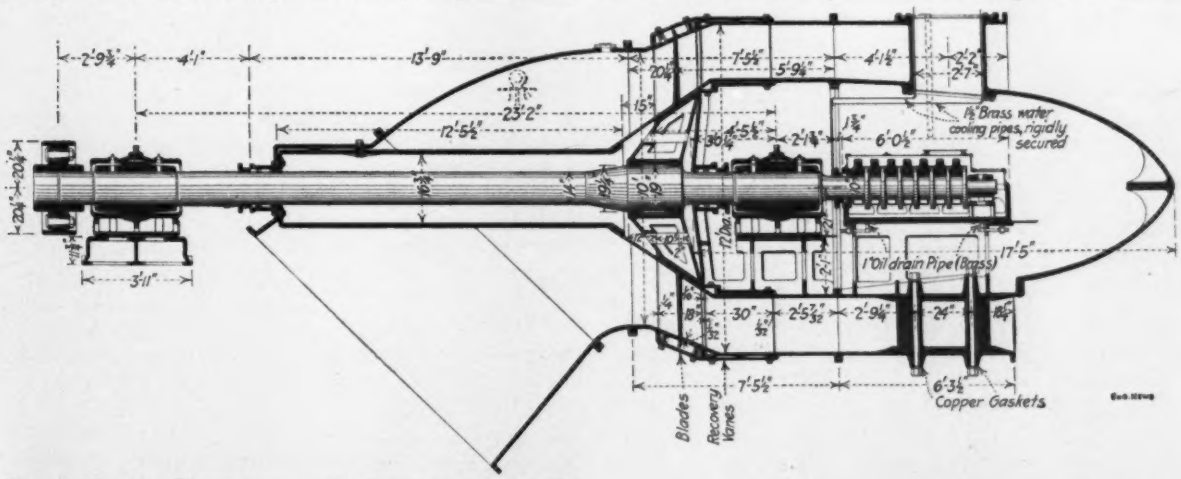
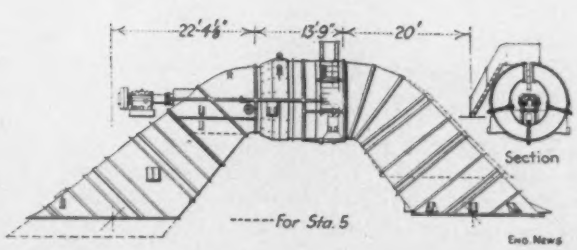


FIG. 4. PLAN, ELEVATION AND SECTIONS OF 12-FT. SCREW PUMPS FOR NEW ORLEANS DRAINAGE STATIONS



ridge, about 5 ft. high, running parallel with the lake. The ridge, however, has no influence on the drainage system.

The city is divided into seven districts with the drainage canals in each district converging upon a pumping station. Sections 4 and 5 are one, though originally laid out as two with Station 4 near the central power house (Fig. 1). Under ordinary conditions District 1 drains to Station 1, which raises the water level in the main canal so that it flows along to Station 2. This in turn takes the main canal waste plus the drainage from District 2 and raises it so it may flow along the main canal to Station 3. Stations 3 and 5 act similarly, the last discharging into the main outfall which is Bayou Bienvenu leading to Lake Borgne. When the aggregate exceeds 3000 sec.-ft. at Station 5, then Station 1 delivers its excess over the canal capacity through the Metarie relief canal to Station 6, which gathers the precipitation from its own district with the excess flow from Station 1 and passes it along to Lake Pontchartrain. Station 2 delivers any excess into the relief canal leading to Station 7, acting similarly to Station 6.

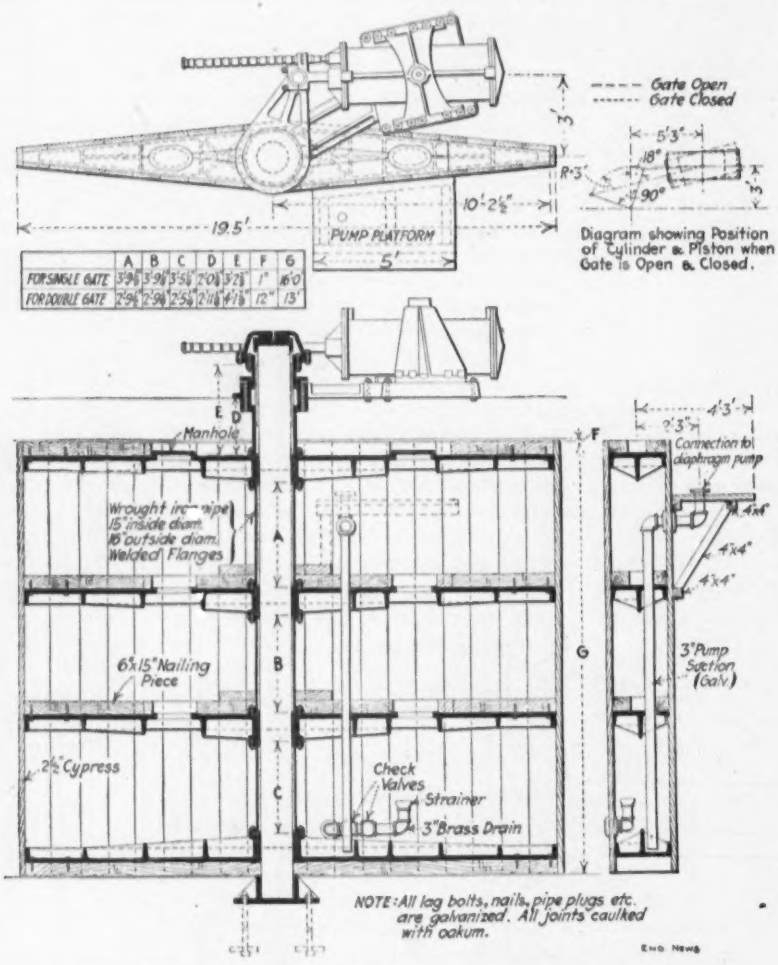


FIG. 5. FLOOD GATES FOR NEW ORLEANS DRAINAGE STATIONS

PLANT EXTENSIONS—The Sewage & Water Board, due to the diversity and magnitude of its work, necessarily has an organization including trained men of ability in several lines of work. This has enabled the Board to adopt a policy of having its engineers work out their problems in detail, preparing specifications for the equipment required for each portion of the extension in such form as to permit bids to be received directly from manufacturers upon definite specifications. Therefore, the new pumps now required for station extensions to care for increased drainage flow have been worked out by the Board's organization. Drawings and general specifications have been issued for eleven units of novel and interesting design. These are all of a screw or propeller type of 500 sec.-ft. capacity (322,000,000 gal. per day) under heads of 5 to 10 ft. The rotor is approximately 12 ft. in diameter and is located in the top of a siphon elbow with one guide and the main thrust bearing inside the main flow pipe.

The original basis for these pumps was a purely theoretical design which was subsequently verified by a series of tests on a 12-in. screw pump built for this purpose, and further verified by the construction and service of a 30-in. screw pump for constant-duty drainage service. This unit is now in operation at drainage station No. 1. It handles about 24 sec.-ft. with a 7-ft. lift, showing an efficiency of 70% or over through a range of 5- to 8-ft. lift.

In the design of these pumps the problem was to obtain units of very large capacity for the removal of storm waters. Since the pumps are operated by synchronous motors the difficulties of starting and keeping them in continuous service increase rapidly with the number of units. Submerged pumps operated by synchronous motors were found to drop out of step frequently, due to lightning on the transmission line, etc., and too much pumping time was lost, due to delay in bringing the units up to step again, it being necessary to slow down one of the engines in the generating station and then to bring it gradually up to speed, driving the distant synchronous motors and pumps until they could be thrown upon the general operating busbars.

To eliminate these troubles of starting under load, the last drainage station, which was built in 1902, was equipped with pumps set above their work—in effect at the summit of a siphon. With this arrangement the starting was a much simpler matter. They are started empty from the general operating bus and then primed. They are more accessible for maintenance and do not require a large check gate to prevent backflow in case of stopping. The large check gates of existing submerged pumps here have been the cause of much trouble and expense in maintenance.

The new 12-ft. screw pumps, therefore, are to be set above the highest level of water on their discharge side

and at the summit of a siphon, as shown in Fig. 4. The outlet end of the siphon will be 14½ ft. in diameter extending down to a level on both suction and discharge sides that will be constantly submerged. These pumps will be designed for two different characters of service: (1) Intermediate lifts between low-level canals, and (2) final discharge into tidewater outlet canals. In the first class the siphons are built with outlet and discharge at the same level. In the second class the discharge outlet is considerably higher than the intake.

The pumps are primed by exhausting the air from the siphon elbow. The specifications call for motor-driven machines (250 r.p.m.) of the rotary type capable of maintaining a vacuum of 29 in. with a 30-in. barometer and a temperature of 80° F. Each pump will be mounted on a bed plate with its motor, forming a unit. Each motor (three-phase, 25-cycle, 220-volt) is to have a speed not more than three times that of its pump, being connected to it by a chain drive or some equivalent. The suction and discharge chambers are of such contour that the bottoms of the screw-pump pipes are water sealed in priming. Two sizes of vacuum pumps are to be used, one of a capacity for 250 cu.ft. of free air per minute and the other for 400 cu.ft.

The priming arrangements of the old pumps is to be changed. Provision is being made to free the pump cases of water (the pumps have submerged runners on vertical shafts direct connected to synchronous motors) or to relieve the motors of all but friction load.

Each one of the new pump motors has its own starting compensator, limiting the current to 1½ full-load value. The old pump motors, under new arrangements, are to be started one at a time and only one starting compensator is required for all old units in each station.

The screw pumps are designed to give a minimum discharge of 500 cu.ft. per sec. at lifts of 5 and 10 ft. from basin to basin, the speed being 55 and 83.3 r.p.m., respectively. For these two lifts, three-phase synchronous motors will be used of 600 hp. in one case and 1200 hp. in the other, working without objectionable overloads at any lift from 0 to 8 and to 13 ft., respectively. These large screw pumps are to be distributed, two in stations 1, 2, 3, 5 and 6, and one in station 7. The extension and foundations of stations 1 are under construction. Contracts have not been let for such work at the other pumping plants. In Stations 1 and 3, each, there will be one 400-cu.ft. vacuum pump. In Stations 2, 5, 6 and 7, each, there will be one 400-cu.ft. and one 250-cu.ft. pump.

Power for operating the new (and old) equipment will come from a new generating station on the west side of the city on the water-purification site. Here is a 6000-kw. turbine unit taking steam from excess boiler capacity in the water-works station.

The combined capacity of the existing pumps of the New Orleans drainage system is about 4600 cu.ft. per sec., the largest units having a capacity of 300 sec.-ft. The eleven new units to be installed, together with additional constant-duty units, will increase the total pumping capacity under storm conditions to some 11,200 sec.-ft. (7,240,000,000 gal. per day), which is more than the annual pumpage of the water-works station.

The design of screw pump is specifically the work of A. B. Wood, who has been in charge of the maintenance and operation of the sewerage and water-works pumping plants; he has had the coöperation of Alfred Raymond, similarly in charge of the drainage pumping stations. The whole design and development has been under the supervision of Geo. G. Earl, General Superintendent (Chief Engineer). The contract for the screw pumps has been secured by the Nordberg Manufacturing Co., of Milwaukee, Wis.; the contracts for electrical drive and control equipment, vacuum pumps, etc., will be let Jan. 30, 1914.

The Four-Mile Mont d'Or Tunnel, French Jura; Heavy Water-Flow in Firm Rock

A short Alpine tunnel in which notable difficulties were encountered was holed through on Oct. 2, 1913, and will probably be completed in a short time. The tunnel is on a new line revision or cutoff extending from Frasne, France, to Vallorbe, Switzerland, and shortening the French main route to the Simplon tunnel. The map, Fig. 1, p. 132, gives a location sketch of the cutoff.* The main ridge of the Jura is traversed by a tunnel under Mont d'Or, 20,008 ft. long (3.8 miles).

The determining reason for building the cutoff was that the previously existing French main route to the Rhone Valley via Lausanne and Martigny was throttled by a single-track section between Pontarlier and Vallorbe. This piece of line had the further serious disadvantages of 2.5% grade, and such severe snow exposure as to be liable to interruption in winter. The Frasne-Vallorbe cutoff eliminates all these difficulties, saves 10 mi. distance, gives a double-track line, reduces the limiting grade to 1.5%, and lowers the summit of the crossing by 370 ft. These are important advantages in a route which must compete with the very direct and modern route from Bern south through the new Loetschberg Tunnel to the Simplon.

Construction of the Mont d'Or tunnel began in November, 1910, immediately on approval of the location by Switzerland (France having approved it some months before). The plan of the line is due to Mr. Séjourné, Chief Engineer of Construction of the Paris-Lyon-Méditerranée Co. The cutoff was divided into seven construction sections. The tunnel contract went to a syndicate composed of Fougerolle Bros., the Etablissements Daydé, A. Palaz, and the Société des Grands Travaux de Marseille.

As indicated in the profile, Fig. 2, the tunnel is on continuous downgrade from the French to the Swiss end, the summit of the cutoff lying but a short distance west of the French portal. On this account it was planned to make most of the advance from the Swiss end. The geology of the mountain chain is somewhat uncertain, and what predictions were obtained as to the amount of water to be encountered proved entirely wrong. The heavy flows were struck near the French side, but in the Swiss heading.

Careful studies of the Mont d'Or geology indicated that the tunnel would penetrate limestone interspersed with some marl layers, and that moderate waterflows were to be expected at two points of the tunnel, with a maxi-

*Illustrations and data from an article by Maurice Honoré in "Le Génie Civil." of Oct. 18, 1913.

mum of about 1000 cu.ft. per minute, which quantity would not seriously hinder the work. Events proved that these predictions were enough in error to make all the difference between easy tunneling and very difficult tunneling. The marl occurred in a very heavy bed, and one of the limestone strata contained waterbearing fissures and faults yielding up to 20,000 cu.ft. of water per minute.

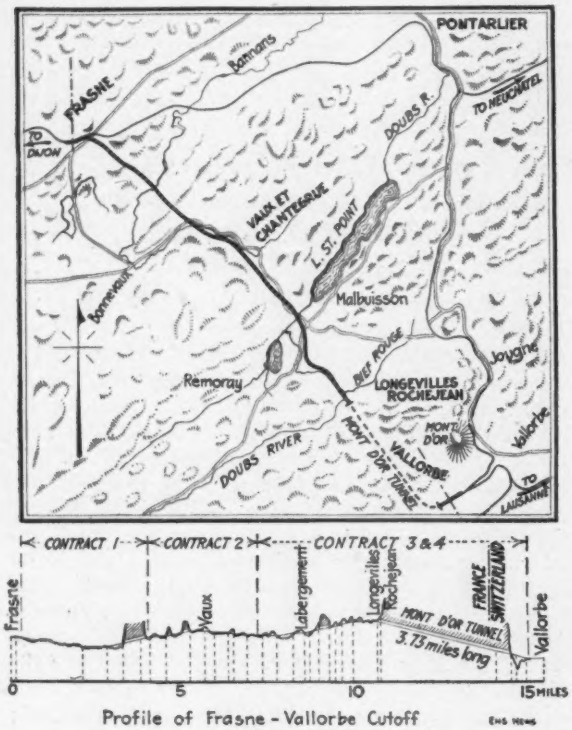


FIG. 1. MAP AND PROFILE OF FRASNE-VALLORBE CUTOFF, IMPROVEMENT OF THE FRENCH SIMPLON ROUTE
(Saves 10 mi. distance, reduces grade from 2.5% to 1.5%, and lowers the summit 375 ft.)

The Swiss heading was begun Nov. 14, 1910, and the French heading about 8 months later. By December 23, 1912, the Swiss heading had advanced 14,320 ft. This represents an average of 566 ft. per month during a total period of 25 months, a very high rate of tunneling.* The method of excavation used in the Swiss end is shown by the seven successive sections in Fig. 3. A bottom heading of 70 sq.ft. was driven, and a short distance back of the face was enlarged to 90 sq.ft. and timbered with square sets. Then upraises were cut from the roof and a top heading driven near the crown, enlarged to the size of the full arch, and the masonry lining put in at once on steel centering. The view Fig. 4 shows some of the stages. Removal of the remaining rock on the floor the upper part of the tunnel permitted the timbering the bottom heading to be removed, and then followed cavation of the side benches and placing of the side-w masonry in sections. The final step was construction the invert and the drainage gutter.

*The softness of the material, limestone and marl, makes the speed of advance less notable, however.

Drilling in the main heading was done both by com pressed-air rock drills and by compressed-air hamm drills, both of Meyer type. Where using rock drills, four were employed, mounted on a tunnel bar. The air was supplied at about 90-lb. pressure. Drilling was carried on in three 8-hr. shifts, each shift, however, usually making two rounds. There were 12 to 15 holes per round, average depth 5 ft. The explosive, 93% gelatin dynamite, was used in charges of 4 to 6½ lb. per hole. The advance per round was about 3 ft. on the average, but sometimes as much as 4 to 5 ft. was made.

The top heading and enlargement work was done by Meyer hammer-drills exclusively.

FIRST WATER-FLOW—On Dec. 23, 1912, a strong outbreak of water near the face of the heading interrupted the work. A few days before, the heading had crossed a narrow fault-seam filled with yellow clay, and on the day noted the clay filling of this seam blew out, discharging a flow of something over 6000 cu.ft. per min. Fig. 5 gives a picture of the conditions at the leak.

On the same day, one of three springs on the mountain above (but three miles distant from) the tunnel, which springs are the sources of the Bief Rouge branch of the Doubs River, ran dry, and two days later the other two also ran dry, cutting off practically the whole flow of the Bief Rouge, seriously inconveniencing various riparian water-users.

Two days after the break-in, the flow fell to less than 2000 cu.ft. per min., but then the effect of heavy rain and melting snow on the mountain increased the flow to about 10,000 cu.ft. per min. on Dec. 28 and 29. After Jan. 10, 1913, the flow was below 1000 cu.ft. per min., a quantity easily dealt with. Before this reduction, however, the water flowing out of the mouth of the tunnel and filling the whole width of the tunnel produced an

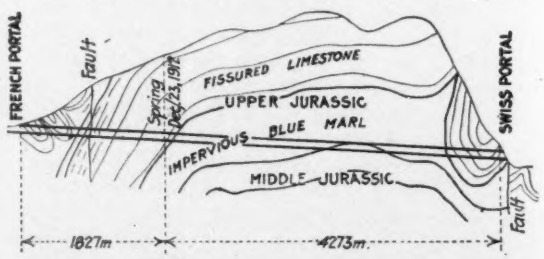


FIG. 2. LONGITUDINAL SECTION OF MONT D'OR TUNNEL, FRASNE-VALLORBE CUTOFF

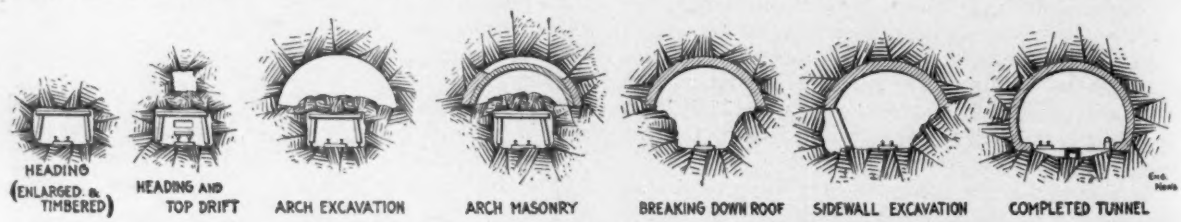


FIG. 3. SUCCESSIVE SECTIONS OF MONT D'OR TUNNEL, SHOWING STAGES OF CONSTRUCTION

enormous washout of the approach fill at the mouth of the tunnel, carrying away a building and tearing out two roadways (see Fig. 6).

About this time, the advance from the French portal, which was being made by top heading and immediate construction of the arch, was stopped (probably on account of fear of encountering similar water-flows at this end, with very much greater trouble resulting, because of the difficulty of handling the water by pumping up the grade to the portal). Subsequently, heading advance at this end was pushed forward about 150 ft., making the total French heading length 3200 ft. At this point a well was sunk to the line of the invert, as a means of making junction with the Swiss heading.

CONTROLLING THE WATER—The Swiss heading in the early days of January, 1913, presented the urgent problem of controlling the water-flow, largely because of the soft marl, whose disintegration by the stream running down the unfinished floor of the tunnel threatened grave results.

To stop the water-flow, a bulkhead 23 ft. thick was built up some distance back of the face, with two drain-pipes built in to discharge the water. When the bulkhead was finished, gates in the pipes were closed, damming back the inflow. Within six days thereafter, all three of the springs of the Bief Rouge had begun flowing again, demonstrating a direct connection between these springs and the water-flow in the tunnel. Back of the bulkhead the full-section excavation and lining work of the tunnel, including invert and gutter, were carried to completion as far as the bulkhead. At the mouth of the tunnel a 32-in. steel discharge flume was put in, capable of carrying some 15,000 cu.ft. per min. After completing these arrangements, the gates in the bulkhead pipes could be opened, the water drained off, the bulkhead demolished, and heading advance continued (Feb. 24, 1913).

March and April brought further trouble. In the latter end of March, continuous rain and melting snow increased the inflow into the tunnel, which in general had not exceeded about 850 cu.ft. per min. Since a flow of 2500 cu.ft. sufficed to interrupt the operation of the tunnel cars, and with over 3500 ft. the tunnel could not be entered, work was often interrupted during March and in the first part of April.

SECOND WATER-FLOW—On Apr. 17, 1913, the heading being about 400 ft. beyond the first leak, the drill steel which was working in one of the bottom holes of the heading was thrown violently out, and followed by a jet of water spurting some 65 ft. back into the tunnel. This new leak was estimated at 500 cu.ft. per min. at first, but because the weather was very wet the flow increased

FIG. 4. VIEW OF HEADINGS, TIMBERING AND LINING, MONT D'OR TUNNEL

enormously during the night and by morning reached 20,000 cu.ft. per min. It was two days before the tunnel could be entered, and it was then found that the first leak had decreased to insignificance. At the same time it was learned that the three river springs on the mountain had again run dry. This meant that the second leak communicated with the springs like the first, but tapped the communication channel nearer the source.

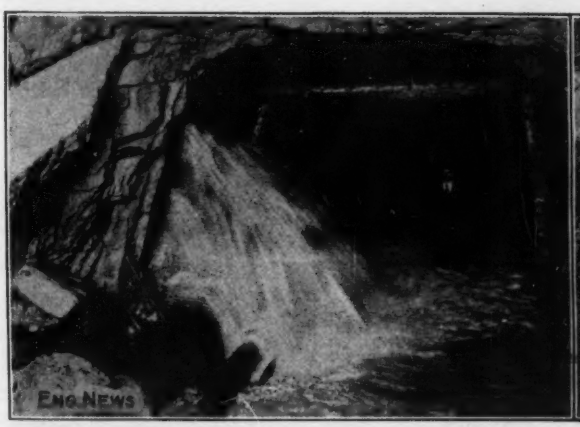


FIG. 5. HEAVY INFLOW OF WATER, SWISS HEADING, DEC. 24, 1912

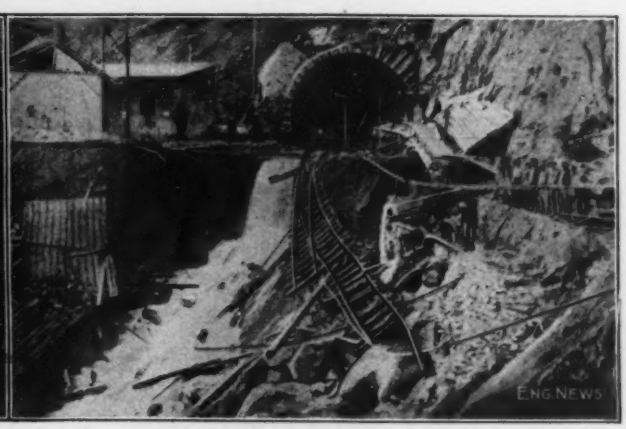


FIG. 6. WASHOUT AT SWISS PORTAL, DEC. 29, 1912. TAPPING A FLOW OF 6000 CU.FT. PER MIN. IN THE MONT D'OR TUNNEL

Drier weather soon reduced the inflow at the second leak enough that advance could be resumed by temporarily diverting the line of the tunnel around the point of leak. Thereafter it was possible to progress forward regularly; junction with the well at the forward end of the French drift was made on Oct. 2, 1913, as already mentioned.

The operations of final completion of the tunnel have not yet been reported.

Crossing the Doubs Marsh, Frasne-Vallorbe Cutoff France

In the construction of the Frasne-Vallorbe Cutoff, France, which includes the recently completed Mont d'Or tunnel, the marshy valley of the River Doubs had to be crossed a short distance west of the tunnel. The crossing proved to be a difficult construction problem. The nature of the marsh soil may be judged from the view Fig. 2, herewith, showing how the ground was upheaved on each side of the railway embankment on the marsh.

The location of this marsh crossing may be seen by referring to the map accompanying our article on the Mont d'Or tunnel (Fig. 1, p. 132). The point in question is just between two lakes lying in the course of the Doubs or its tributaries; probably the lakes were once continuous, and the land now separating them is lake deposit. Only the westerly half of the valley is of marshy character, as indicated in the section Fig. 1, herewith. Soundings and a test well showed the depth

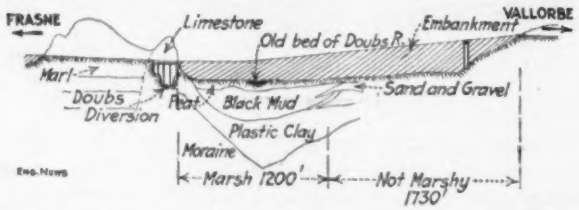


FIG. 1. SECTION OF STE. MARIE MARSH CROSSING OF FRASNE-VALLORBE CUTOFF, FRANCE

of soft material to be more than 200 ft., the upper half of this being sticky black mud.

The marshy section was only 1200 ft. wide, but within this width the river had to be bridged. The construction and maintenance of a bridge and its abutments were hardly feasible under the circumstances. It was decided to get around the difficulty by diverting the river around the westerly edge of the marsh, where a rocky elevation borders the valley (rock foundations for the bridge piers being thus secured), and crossing the marsh by continuous earth fill.

The embankment across the valley approximates 300,000 cu.yd. of fill, of which about half is on the marsh. The material for the fill was taken from the cut through the rock ridge west of the marsh.

Construction work was begun by dredging the diversion channel toward the rock cliff, and at the same time taking out the cut in the rock from the surface, depositing the spoil in the railway embankment. Soon after beginning the embankment, however, the marsh soil squeezed out in waves on either side, as shown in Fig. 2. The marsh wave was about 200 ft. wide and 12 to 15

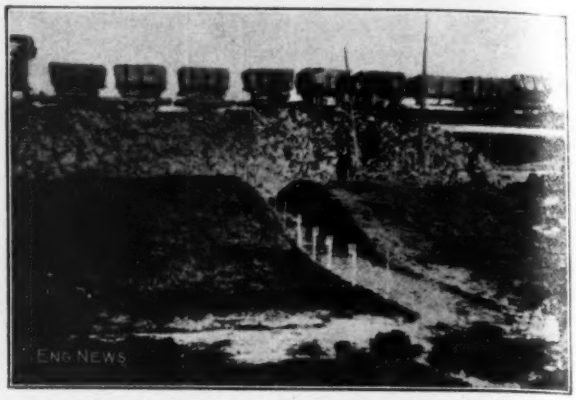
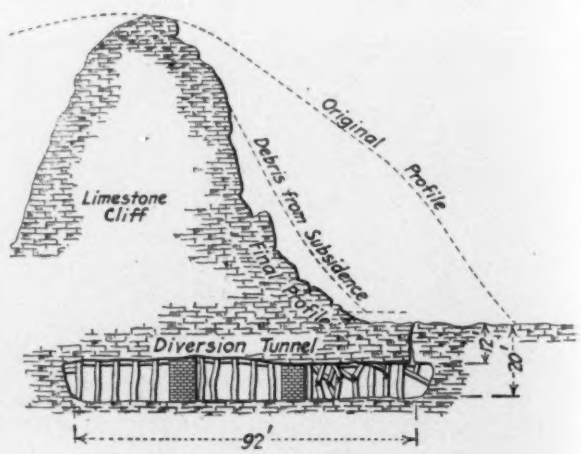


FIG. 2. UPHEAVAL OF MARSH BY WEIGHT OF RAILWAY EMBANKMENT

ft. high. There was danger that continuing the fill would extend the swell wave to the old river bed, blocking the river and flooding the marsh before the diversion channel was finished. It was therefore decided to stop work on the fill and put through the diversion by mining or tunneling.

Fig. 2 illustrates the diversion tunnel in cross-section. The opening was 100 ft. wide and 6 ft. high, the roof being supported by several masonry walls and a large number of timber posts. On Apr. 16, 1913, the weight of the rock sheared off the rock at the thinnest part of the roof, at the foot of the easterly talus slope, crushing down some of the supports (Fig. 2). The remaining supports held, however, and work on the diversion progressed to completion May 7, 1913, on which date the end bulkheads of the tunnel were torn out and the river finally passed through the diversion. Thereafter, the old bed was filled and the railway embankment continued across the valley.

The above data are from an article on the entire cutoff, by Maurice Honoré, in "Le Génie Civil" of Oct. 18, 1913. He states also that the embankment is expected to give trouble for some time, requiring continuous addition of material until the flow of material from under the embankment has brought about a condition of equilibrium in the marshy soil.



Cross-Section of Diversion Tunnel under Cliff

FIG. 3. DIVERSION DRIFT FOR DOUBS RIVER

Editorials

A Stop to Railway Electrification Work

Compulsory electrification of the railway terminal lines at Boston has been one of the most prominent subjects before each session of the Massachusetts legislature for several years. This year for the first time it is safe to say that nothing will be heard of the matter. That the Boston & Maine and Boston & Albany systems have no money with which to finance any electrification project is evident this year not only to the railway officers but to the public. Practically the same thing may be said of the New York, New Haven & Hartford Co., which in previous years has been lavish in promises as to what it would do in the future in the way of electrification.

It would be of great interest to know just how much money the New Haven company has expended, first and last, upon its electrical equipment, including not only the first cost of construction but the heavy operating cost during the time when the system was being worked out to an operating success. The general purport of such semi-official statements as have appeared has been that the investment in electrification has been an entire loss from a financial point of view, since it has resulted in no reduction in operating expenses.

It is true, of course, that a certain part of this electrification work in connection with the Grand Central terminal in New York City was made compulsory upon the company by law. The work has been carried out, however, on a far more extensive scale than the law required and has been held up to the engineering world as an example of enterprise and progressiveness in the railway industry. In view of other developments in connection with the New Haven financing, however, many will be skeptical enough to doubt whether this enormous expenditure on electrification was influenced solely by desire to benefit the company. It would perhaps be a fair summary of the New Haven's experience in railway electrification to say that while such work may be magnificent finance, it has proved very poor business policy.

The Breaking in Two of the "Oklahoma"

The wreck of the oil-tank steamer "Oklahoma," soon after leaving the port of New York, last week, is of especial interest to engineers because of the fact that the wreck occurred through an actual breaking in two of the hull of the vessel from wave action. The "Oklahoma" was a comparatively new vessel, having been built in 1908 at the shipyards of the Maryland Steel Co., at Sparrows Point. She had just left the port of New York and was outward bound in ballast for Port Arthur, Tex., to take on cargo. About 50 mi. off Sandy Hook, in a very heavy sea, the hull broke in two amidships. The engine room in the after part flooded, and the engineers escaped so hurriedly that they had no time to close the throttle, so the engine continued to run until the after-part of the vessel sunk, some 30 min. after the break in two occurred. It would appear from this that the bulkheads in the after-part must have held long enough to considerably delay the entrance of water to the hold.

The forward part of the vessel continued to float for a much longer time, and eight men who were in the forecastle when the break occurred were finally rescued. The forward part capsized later and was found by the revenue cutter "Seneca" floating bottom upwards, and was sunk as a menace to navigation.

Such break-in-twos of the hulls of vessels, while they have occurred before, have been rare enough so that the "Oklahoma" disaster is of especial interest to vessel designers. According to the story told by one of the surviving members of the crew, reported by a daily paper, the break-in-two occurred "when the vessel was picked up at either end by giant waves. While she hung thus suspended, a third great comber washed high over her side, and settled with a deafening crash on her deck."

What most probably happened was that the break-in-two occurred when the vessel amidships was raised high on the top of a wave, while the stern and bow were in the trough on either side. This would place the vessel's bottom in compression, and the top deck and sides of the hull in tension. A ship's hull is weakest to resist a bending stress under these conditions since its bottom plating is heavier than its deck plating and the latter is cut away for hatch openings. The stresses were a maximum, also, because the vessel was not loaded. Under these conditions, the principal weight in the hull is that of the engines and boilers in the after-end, and the ballast in the tanks at the bow to keep the vessel on an even keel. With the load thus concentrated at the two ends of the hull and the central portion empty, the bending of the hull, produced by a wave lifting the vessel amidships would be a maximum.

Similar cases of hull failures on the Great Lakes, a dozen years or more ago, resulted in an increase in the required thickness of the hulls of lake vessels. The wreck of the "Oklahoma" will probably have a distinct influence on the design of ocean tank vessels.

Coast-Protection Works

The heavy damage suffered by seashore property on the New Jersey and Long Island coasts during the recent severe northeast storms may well call attention to the almost total neglect in this country of the art of coast protection. This branch of engineering work has been developed to a high degree in England and Holland particularly, and much work has also been done on the coast of France. In the United States, however, so far as we are aware, there are only a few isolated examples of coast-protection work in which the services of engineers have been enlisted.

Along the New Jersey coast, almost the sole protection in use is the so called bulkhead, built along the beach, usually at a location well above high water, and intended rather to protect the area behind it from exceptionally high tides or from wave action in extraordinary storms than to make permanent the beach itself. If, however, the ocean currents are actually eroding the beach at a given point, it is only a question of time when the bulkhead will be undermined or exposed to a wave action in heavy storms that it cannot long withstand.

Successful work in shore protection in Europe has mostly been accomplished by the use of so called "groynes," which are low barriers running down the slope of the beach at intervals, and intended to stop the erosive action of the current along the shore, rather than to hinder the back-and-forth movement of the surf. These are often supplemented by a protection of reinforced concrete or other materials on the slope of the beach itself.

It will hardly do to blame American engineers for not having developed this branch of engineering work, since there has been little inducement to undertake such work in this country. The Federal Government confines its work on the coast to structures which may aid navigation or which have to do with fortifications for national defense. The United States engineers undertake coast-protection work only in cases where beach erosion may interfere with plans for fortifications or with navigable channels.

The State governments, so far as we recall, have paid no attention to the matter of coast protection, holding, doubtless, that it was a matter for the private property owners concerned. These property owners have generally held that ownership of seashore property was more or less of a gamble anyway, and there have been few instances of any concerted action among them to take measures looking to the protection of any long stretch of coast on scientific principles.

The enormous value now attaching to seacoast property near the large cities of the East, however, ought to bring about a better recognition of the wisdom of safeguarding this against possible entire loss. It is doubtless true that the attack of the sea on the Atlantic Coast beaches is less severe than on the exposed coast of England. The work of the recent storms, however, is an effective reminder that all along our sandy coasts there is always a chance of large and sudden changes occurring, the beach being heavily eroded at one point and extended at another. The cost of adequate foreshore protection in front of such valuable property as that at Atlantic City or Seabright, or twenty other summer resorts on the Eastern coast, would be only a very trifling percentage of the value of the properties which would be protected.

Speed-Reduction Signals on Railways

On all railways there are points at which speed must be reduced, either by all trains or by certain fast trains. At some of these points the speed reduction is a permanent condition, as at sharp curves in open track or at junctions and connections. At other points the speed reduction is a temporary condition, as where ballasting, rail renewals, grade-reduction work or other improvements are in progress. Notice of these conditions may be given to the enginemen by slow-orders posted on the bulletin boards at the engine terminal and printed on the time-tables, but it is not easy for a man to keep all these points clear in his memory, together with all the various other orders and instructions.

The places requiring temporary reduction of speed are marked usually by flags set out by the working gangs. These are not very conspicuous as a rule, and are set too low to readily attract the enginemen's attention. The marking of places requiring permanent reduction of speed is less general, and the enginemen are assumed to be familiar with such points on their regular runs. Even where some form of signal is used this is usually a daylight signal only, consisting of a "slow" sign or a fixed semaphore. The men running fast night trains must depend upon an intuitive knowledge of the road as their guidance in regulating the speed. The block signals alone do not furnish warning for such cases, except perhaps for turnouts, and then only to men who are thoroughly familiar with their runs and are careful in handling their trains.

Several very serious accidents due to excessive speed on curves have occurred on American and English railways within recent years, and in some of these the lack of special speed-reduction signals or signs appears to have been an important contributory factor. One such case was the wreck of the steamship express train on the London & Southwestern Ry., in 1906, when a number of American passengers were killed. This was discussed at some length in our issues of Aug. 9 and Dec. 6, 1906, and it is a sample of several similar accidents. In this case the curve was on the open main line, and there was a standing order requiring speed to be reduced to 30 m.p.h. In other cases the curve was at a junction or track connection, which was the condition in connection with the two serious accidents on the New York, New Haven & Hartford R.R., when fast trains were derailed while running through main-track crossover connections.

In an accident on the London & Northwestern Ry., England, in September, 1912, a fast train was put in charge of a man who had made but a few runs over the division, while his last run over it had been nearly a year previous. At Ditton the train was to be transferred from the high-speed to the low-speed line, and there was a speed limit of 15 m.p.h. for passing this connection. The signals were set for the slow line but as the engineman was not familiar with the line or the signals he probably noted only that he had a clear signal and saw nothing to indicate that he should reduce speed.

The train, which was running at about 50 to 60 m.p.h., left the track on the curve and there was a bad wreck. The investigation showed that while men were supposed to be examined as to their knowledge of the road this rule had come to be practically disregarded. Men going on duty (outside of their regular runs) were simply asked if they knew the road and it was hardly to be expected that they would admit ignorance, especially in such an informal and casual inquiry by a roundhouse foreman.

As to the signals in this case, the home and distant signals for the slow-speed line were originally at the same elevation as those for the high-speed line, but after the accident the former were lowered. The government inspector, however, advised eliminating the distant signal for the slow-speed, and using but one distant signal, which could be lowered only when the high-speed line

was clear. Thus trains for the slow-speed connection would always have the distant signal set to check them. A special speed-limit signal for such cases was suggested by the inspector, as follows:

> If the railway company prefers to retain the distant signal for the junction from main track to slow track, there should be a board fixed below every such distant signal with a number indicating the speed limit, and the figures should be uncovered by the lowering of that signal. Normally the board would be blank, and the figures would be visible only when it was intended to turn the train from the main onto the slow line, and the distant signal for the latter line was lowered.
>
> The board should be illuminated at night, either by making the figures transparent and having a light behind them, or in some other way. A board of this description would act as a reminder to the driver that when he had to be turned from the main to the slow line his speed should be reduced to 15 m.p.h. It would be similar to the boards now in frequent use at the entrance to terminal stations to indicate to the drivers the platforms to which they are to run.
>
> There seems to be something illogical in lowering a distant signal, thereby telling a driver he may proceed without a check, at places where it is absolutely necessary for him to reduce the speed of his train to, say, 15 m.p.h. The sole object of signals is to convey information and instructions to enginemen, and if by some simple means it is possible to increase the amount of information so conveyed it would be an advantage.
>
> At places on a railway, such as curves, where every train without exception has to reduce speed, the use of permanent speed boards, which are employed by most railways, but not by the London & Northwestern Ry., meets the case. There are 37 pages (closely printed) in the speed book, and the limitations, which are about 1000 in number, vary from 60 to 5 m.p.h. What proportion of such a list can a driver be reasonably expected to carry in his head? In my opinion, drivers are entitled to every assistance in this respect, and speed boards, which should be illuminated at night, afford a ready means of helping their memories.
>
> But at a facing junction, such as the one under consideration, a permanent speed board cannot be employed, as the authorized rate of speed varies according to the route which the train has to take when it reaches the junction.

A speed signal and indicator designed for an English railway has a lantern with a 24-in. dial of opal glass, on which the speed limit is painted in black figures. This is illuminated at night by a long-burning oil lamp, which will burn for a week without attention. The signal is mounted on a 10-ft. post and serves for both day and night indication. Various signals of this class have been devised in this country, but they are used only to a very limited extent. In one case there was a target having the lower half green and the upper part yellow, with two bull's-eyes for lamps on the center line, showing the two colors. Another had an illuminated "S" on the target. Neither of these showed the speed limit required.

On the Pennsylvania R.R. system all main-line curves on which a speed limit of 45 m.p.h. is set, are marked by fixed semaphore signals at each end, so as to indicate to the enginemen when to reduce and when to resume speed. The semaphore blade is 3 ft. 6 in. long, carried by a 3-in. pipe post set in concrete and rising 10 ft. 6 in. above rail level. The signal at the entering end of the curve has the blade inclined 45° downward, while that at the leaving end of the curve has the blade vertical. There are no lamps, however, so that at night there is no indication. This is a decidedly weak feature of most slow signs, but where there are many such curves the difficulty and cost of maintaining so many lamps is one objection to a more effective system of caution signaling of this kind. On the other hand, such a condition would suggest the advisability of a permanent improvement in the way of curve reduction.

There is evidently a field for the introduction of auxiliary signals of the character recommended by the English engineer quoted above, both for permanent and temporary conditions of speed reduction. In another column we give the views of a German engineer as to these slow-speed points on train lines.

The Financial Troubles of State Irrigation Work in Australia

In our issue of June 12, last, we reviewed in these columns the difficulties which the promoters of irrigation enterprise in the arid West are experiencing, in obtaining a satisfactory return on the money invested in irrigation works. We then showed that the chief trouble is in getting farmers to purchase the irrigated lands who have the necessary qualities of industry, grit and intelligence, to cultivate the land at a profit. This difficulty is met alike by the irrigation work carried on with Federal funds under the United States Reclamation Service, by the work carried out under State control, by that done through mutual coöperation of the land owners and by works undertaken by private enterprise in hope of profit.

This subject is brought up anew by the very interesting paper, by Mr. D. C. Henny, published elsewhere in this issue, whose long experience in irrigation work, both under Government direction and under private enterprise, qualifies him to speak with authority. We commend especially to our readers the judicial manner in which Mr. Henny discusses the controverted subject as to the relative efficiency of government irrigation work and of work carried on by private enterprise.

It is of no small interest in this connection to know that some of the Australian colonies are passing through an experience in irrigation works similar to that of the arid West. In the colony of Victoria, a large part of the irrigation work which was originally undertaken either as a private enterprise or on the coöperative plan, has been taken over by the State on account of the financial difficulties which the projects experienced. The State has now invested nearly $23,500,000 in irrigation works, of which amount only about one-third is returning a 4 per cent. interest on the investment.

The chief difficulty in Australia, as in the United States, appears to be to place settlers upon the newly irrigated lands who are able to make good and eventually to pay off the money which has been invested to create their farms and homes. The immigrants from England to Australia are more apt to stay in the cities than go on to farms, and few of them have either the capital or the practical knowledge of farming, particularly of farming under irrigation, which would enable them to settle on an irrigated tract and cultivate it at a profit. Notwithstanding all that has been done in the construction of irrigation works and the improvement of methods in irrigation management during the past five years in Australia, the *Melbourne Age* says that the area irrigated in Victoria last year, 213,333 acres, was nearly 17,000 acres less than that irrigated in 1908.

It is proposed to attempt to cope with the difficulty above set forth, by establishing a model irrigation tract, to be placed under direction of a high-class expert in methods of agriculture under irrigation. By a short course of training given at such a place, to those who propose to settle on irrigated lands, it is hoped to aid settlers to avoid the mistakes that so often bring them to destitution.

Letters to the Editor

The Admission of Civilian Engineers to the U. S. Engineer Corps

Sir—Your editorial in ENGINEERING NEWS, of Jan. 1, entitled, "The Admission of Civilian Engineers to the United States Engineer Corps," is interesting and timely. Your quotations from the report of the Chief of Engineers make it evident that the law has been so very much emasculated in its execution that its purpose has not been carried out and the reasons for this would be interesting. I do not know these reasons, but I can point out why "only one probational second lieutenant was appointed from civil life."

I admire the Engineer Corps and, together with a number of my fellows, would soon change that phrase of "only one," *if* we had a *real* chance. Here is the secret evil—the qualifications for admission: First, to be eligible to even *take* the examination for second lieutenant, one must be on the eligible list of the United States Civil Service as a Junior Engineer. This examination itself calls for "at least five years' *good* experience in civil engineering work." A degree of C. E. from a good school counts for 3½ years of this, but the other 1½ years must be in something higher than such "minor positions as chainmen, rodmen and levelmen." If a young graduate engineer is lucky, he can get a transit in a year after leaving school—and that is a mighty conservative estimate, as some of us ruefully admit.

Then he takes the Civil Service examination and, if he has kept in reasonable touch with what he learned at school, he passes this. He is now eligible for examination for the grade of Second Lieutenant of Engineers. This includes a moral, physical and mental examination. This mental examination covers everything—English grammar and orthography, general history of the world, French, German or Spanish, constitutional and international law, law of contracts, physics, chemistry, geology and mineralogy, elements of electrical engineering, general and practical astronomy, topographic, hydrographic and geodetic surveying, theoretical and applied mechanics, theory and practice of engineering construction (including every possible kind of engineering work) and materials of construction.

"No candidate will be considered as having passed a satisfactory mental examination who fails to attain a general average, of at least 80%, or who fails to attain a mark of at least 70% in each and every subject."

Is it any wonder that there was "only one"?

Then, if he passes all requirements, he is appointed, "*after* the graduating class from West Point" have been commissioned and is put on probation for a year, during which time he studies more, and then has another and more rigid examination. By this time our hero is about twenty-six years old, with a C. E. degree from a good school (Cornell for instance), 2½ years' experience in good work in civil life, and a year in the Engineer Corps—and he is a junior, and will be to the end of his days in the army.

If an inexperienced West Point graduate were to seek entrance to the Civil Engineering College at Cornell he would be accepted as a member of the senior class, needing a year of work to get his degree. For instance, every year two *first* lieutenants of the Engineer Corps come to Cornell and are enrolled as members of the senior class in Sibley College of Mechanical Engineering, and take the regular senior work.

Is there still any wonder that there was "only one"?

The above quotations from the requirements have been made from General Orders No. 139, of the War Department, secured from the Adjutant General when I had fond hopes of joining the Engineer Corps myself. If every member of the Engineer Corps had to take such entrance examinations to enter it, the Corps would be seriously depleted.

Even the mental examination above cited would not be so bad, if our C. E. degree from a good school would admit us directly to it, but as the situation now lies, no man in his right senses is going to drop a good position and just throw away four years of his life and go back and start all over again, with such a handicap as I have pointed out.

I hope that your editorial and this comment, perhaps, will come to the eyes of the powers-that-be, so that they may, perchance, tell us the reasons why it is so.

R. E. J. SUMMERS.

Cornell University, Ithaca, N. Y., Jan. 1, 1914.

Sir—Your editorial, "The Admission of Civilian Engineers to the United States Engineer Corps," ends with a question very similar to that which a lady asked an army officer on a steamship where the writer was traveling last summer. The writer was seated directly across the table but did not wish to discuss the question there. The lady asked why there were none but West Point men in the Corps of Engineers. The officer replied, "Because no others can pass the examinations." It would be a fair inference from his answer that any graduate from another engineering school who could pass an examination with as high rating as the West Pointer would have an equal chance of admission to the Corps. Surely an army officer's sense of honor should debar him from making such a false claim of superiority for his school.

B. W. A.

New York, Jan. 3, 1914.

Sir—I am constrained to answer your query, "Why for two whole years nothing whatever has been done toward filling those vacancies in the U. S. Engineer Corps"? Because it is a one-man organization and military supremacy and discipline destroy the personal initiative and independence. All questions are settled by boards, whose personnel is constantly changing, and hence the ordinary incentives are removed from the local

official who is not in one place long enough to complete his own plans or get credit for his work.

Civilians in the service as employees must do as they are bidden and testify under oath as instructed on pain of dismissal, and they seldom get credit for their plans. Within a few months I have had ample opportunities to note the workings of the system and have knowledge of civilians seeking to get away from the paralyzing influences of the service.

H. L. U.

Jan. 2, 1914.

The Engines of the Mahanoy Plane

Sir—I was much interested in Mr. Ward's article in ENGINEERING NEWS, Dec. 18, p. 1220, on the Mahanoy Plane, because I was in active charge, as Chief Draftsman under John Wood, Superintendent of Shops and Machinery (P. & R. C. & I. Co.), of the design and construction of all the mechanical equipment. A more detailed account of the engines might be of interest to your mechanical readers. The old engines were 45x60 in., with 14-ft. drums, operating on the Whiting system, the two drum shafts being connected by parallel rods operating between the main connecting-rods and the cranks. Thus the main crankshaft was the farther from the cylinders, making a very compact arrangement.

The principal troubles experienced with the old engines were short life of bearing-liners and pin-brasses, cracked bedplates, loose foundation-bolts, and frequent renewal of drum-blocks, for the old drums were wood-lagged.

In the design of the new engines great care was taken to avoid these difficulties; and I believe the results have fully justified the means. Anyone can appreciate the difficulty of maintaining the parallel rods exactly equal in length, and that any inequality, with the bearings separated by a rigid bedplate, is sure to cause heating of the bearings or pins.

Consequently, the first step was to do away with the parallel rods and, as gears were manifestly impracticable at the speeds contemplated, this meant that one drum must do all the driving. In order to secure enough friction surface on the ropes it was necessary to double the number of laps that the rope makes on the drum, which proceeding greatly increased the load on the main bearings and led to the introduction of rollers to take this load off the bearings. There are three pairs of rollers of equal diameters, one each side of each drum and an intermediate pair to rectify the direction of rotation. Those on the crankshaft being weighted on one side to partially counterbalance the cranks, it being found difficult to accomplish this in the crankdisks alone.

As it was, of course, impossible to avoid entirely the necessity of renewing the bearing-liners, it was sought to facilitate the operation by providing roller-bearing screw-jacks, one under each of the main bearings, enabling it to be raised enough so that by blocking under the drum and releasing the jacks, the bottom liners could be swung around on the shaft. To avoid binding at the sides, the center of the spherical seat of the liner was fixed somewhat above the center of the shaft. The jacks are geared together so as to insure equal lifting at each end of the shaft, and are arranged for a power drive.

To avoid cracking, the bedplates were made extra deep and, instead of being plane on the bottom, the part under each main bearing was made 18 in. deeper, so that this projecting part, when grouted in place, greatly assists in holding the engines securely on the foundation. The foundation bolts too, were made extra heavy and were all through-bolts with nuts on each end, permitting them to be withdrawn in case of breakage. Some of these bolts are 4 in. in diameter and more than 16 ft. long.

The drums are of cast steel throughout, except the differential rings (one for each rope), which are made of wrought iron, to reduce the wear of the ropes. Each ring is made in halves riveted together. The hubs instead of being keyed to the shafts, have a square fit; the split comes on the diagonal center line of the square. The same idea was used in fitting the lifting-arms on the reverse shaft.

The valve-gear is all on the outside, instead of between the engines as is common; it is driven by a separate shaft for each engine, operated by a return-crank from the main crankpin. This was done to reduce the length of the main shafts to a minimum, keep down the size of the eccentrics, and have the whole valve-gear easily accessible. It was also possible with this arrangement to get the whole valve-gear in one straight line, without the usual offsets. There are three eccentrics on each side and two piston-valves on each cylinder, arranged one above the other.

These engines, I believe, are the most powerful ever built for such a purpose. The Ashley planes handle less tonnage and operate at much slower speed; the Cuban planes mentioned in your editorial (Dec. 18, p. 1247) are used for lowering the main loads, rather than for hoisting; so that the engines in both these cases are much smaller and the drums are gear-driven. I believe also, that these are the heaviest loads ever handled with differential rings; it will be a matter of considerable interest to learn how they stand the test.

R. A. WRIGHT.

Chief Draftsman, Hydraulic Dept., Wellman-Seaver-Morgan Co.

Cleveland, Ohio, Dec. 23, 1913.

The Serra Inclines of the Sao Paulo Ry.

Sir—I have read with considerable interest the article in your issue of Dec. 18, describing the reconstruction of the Mahanoy Incline, and your editorial comment. You may, therefore, be interested to know of the Serra Incline of the Sao Paulo Ry., in Brazil, which is quite famous among those familiar with that part of South America. That this line has been recently reconstructed (as was also the Mahanoy Incline) makes the subject of especial interest at the present time.

The Sao Paulo Ry. is a short line, about 90 miles in length, and of 5-ft. 3-in. gage, running from the Port of Santos to Sao Paulo and Jundiahy, in Brazil. It affords the only connection between Sao Paulo and the coast and has tributary to it, some 1000 km. or more of the upper end of the Brazil Ry. Co.'s system, as well as practically the whole of the Paulista and Mogyana railways. The latter two together, aggregate about 2500 km. in length and reach the rich coffee districts of Brazil tributary to

Sao Paulo. Besides other freight, therefore, all the coffee exported from Santos, amounting to some 500,000 tons per annum, passes over this line as do practically all the imports for the richest districts of Brazil. In addition, it has a fairly large passenger traffic.

The country served by these tributary railways is an elevated plateau situated at an altitude of about 2500 ft.; the rise to which from the coast is very abrupt. Soon after leaving Santos, therefore, going inland, the railway has to make this climb, which it does in a series of five inclines aggregating 10 km. in length with 8% gradients, operated by endless cables.

The original line was first opened to traffic about 1870, and has four inclines on 10% gradients. The present line was built in the late nineties and opened to traffic about ten years ago. It was built in an entirely new location, though more or less in the vicinity of the old line, which latter (although it has, I think, not been worked since the new one was opened) is kept in such condition that it may be utilized if necessary.

The construction is very heavy, involving many tunnels and bridges. There are 13 tunnels with a total length of 1350 m., 14 bridges 1380 m. in total length, containing 4000 tons of steel and two masonry viaducts. Among the interesting features most notable on a first visit to the line is the elaborateness of the ditching and the amount of care and attention given to the roadbed and right-of-way. The incline is located along the side hills throughout its whole length; ditches are cut in every direction on the steep slopes on the upper side and along the sides of the roadbed, all lined with concrete and painted with black paint (probably a tar or asphalt preparation). This latter is probably frequently renewed, for it all looks fresh and clean; the slopes are covered with grass which is kept trimmed, and the tropical vegetation and trees which elsewhere cover the slopes of the mountains are kept well back from the line.

The general impression seems to be that these elaborate ditches and the scrupulous care shown in the maintenance of the right-of-way are the result of an attempt to expend the large profits of the line. It is possible, of course, that the profits make these precautions possible, but the extremely heavy rainfall makes the [illegible]ery desirable, especially on a line of this character [illegible]hich is the only connecting link between an extensive [illegible]tem of railways serving a rich and fairly well populat[illegible] section of the country, and the coast.

There is a separate hauling plant and cable for [illegible]ach of the five inclines, which are worked simultaneously. Five trains are always ascending and five descending when the inclines are operating; the trains are arranged to approximately balance each other. This system, which is operated by endless cables, necessitates a double track, but in order to reduce the expense of construction, the tracks are laid with three rails (one common to each track) widening out to passing places, at the levels between each of the inclines and half way between, as shown in the photographs.

The track is laid with 90-lb. rails, and the trains are handled by special locomotives, having their own steam power to move the trains onto the incline and along the levels between the inclines and between the cable sections. They have a form of grip for attaching themselves to the cables; the latter are operated by stationary engines of about 1000 hp. capacity each. The locomotives are always placed on the lower end of the train.

TWO VIEWS OF THE SERRA INCLINES ON THE SAO PAULO RY., BRAZIL

The cables are about 1¾ in. in diameter and run on grooved pulleys supported on the ties in the center of the track on tangents, and nearer the inner rail on curves. They are made of six strands of steel wires on a hemp core, and are said to have a breaking strength of 108 tons when new and 72 tons when worn; the maximum working load being 18 tons.

The maximum weight of trains which can be hauled on the inclines is 145 tons; the locomotives weigh 31 tons and, of the remainder, about 70% is paying load. The time required to pass each section of the incline is eight minutes, so that the maximum traffic capacity is about 600 tons per hr. in each direction. The locomotives and trains are fitted with automatic vacuum brakes on all axles. The traffic is said to be fairly well balanced.

Many of the details given above are taken from a descriptive pamphlet issued by the railway company. This

section of the line, on account of its scenic attractions, is visited by many of the passengers of the steamships calling at Santos.

It is said that a location has been found for a practical adhesion line on about 2% grades, down this hill. One's first thought on looking at the country would be that such a line would be far more economical to operate than the inclines. It is probable, however, that the comparatively economical use of power by reason of the balancing of the loads, and the greater economy of the stationary steam plants is enough to, at least partly, compensate for the interest charges on heavy first cost of the plant. The balancing of the traffic is, of course, a most important consideration. There is also the additional length of the developed line on the lower rates of gradient and many other factors to be considered before deciding on the adoption of such a scheme as this. It seems probable, however, that the great progress in the development of the heavy steam locomotive during the past 15 years, since the present inclines were designed, might greatly alter the determining factors.

FRED LAVIS.

50 Church St., New York City, Dec. 19, 1913.

NOTES AND QUERIES

The data given in "Excavating with Large Scrapers," "Eng. News," Dec. 25, p. 1302, should be changed to read as follows:

Under **"Labor,"** "14 teams and drivers @ 45c. per hr....$63 should read, 10 teams and drivers @ 45c. per hr....$45. This change will make the "total cost of labor per 10-hr. day," $53 and the "Cost of labor per cu.yd. excavated," $0.106. The last two lines, in accordance with the above revision, should read:

Total cost of work, per day	$75.20
Total cost of work, per cu.yd. excavated	0.15

B. S. L. writes:

I was recently employed by an electrical engineer of some prominence to carry out some extremely important work in connection with a water-works system. This engineer had taken the work, although he had little knowledge of this branch of engineering.

What is to be the status of the engineering profession a few years hence when electrical engineers handle water-works jobs or vice versa, or any other ludicrous combination? How can engineers who do not maintain permanent organizations secure work when it is self-evident that it will be necessary for them to employ men to handle the work upon whom the success of the undertaking will be entirely dependent. Many engineering failures can be traced to this method of handling work. Engineers undertake to handle work with which they are not familiar; if they were able to engage an experienced and conscientious assistant everything may turn out all right, providing, of course, that sufficient time is allowed. But often the reverse is true, for people doing work in this way do not, as a rule, allow sufficient time to do the work properly, simply rushing it to completion without considering the outcome.

The Bactericidal, Deodorizing and Physiological Action of Ozone

[Several letters have been received by this journal presenting arguments for the use of ozone because of claimed therapeutic and deodorizing virtues, but we have not continued to publish them in view of their lack of new evidence over that in those already presented *pro* and *con* (see ENGINEERING NEWS, Nov. 27, and Dec. 25, 1913). We have noted, however, a letter by M. W. Franklin, in the January issue of the *Journal of Industrial and Chemical Engineering* of the American Chemical Society, which seems to approach this discussion in still another way. To be entirely fair to all interested parties, we are reprinting portions of his letter below. Dr. Franklin has been in charge of the development of ozone devices and processes for the General Electric Co., and now continues in that office for the Sprague Electric Works, a subsidiary of the same company, to which these matters have been delegated.—ED.]

Ozone is applied to ventilation for the purpose of destroying odors which result from the presence of people, animals and decaying organic substances. Its value is demonstrated in numerous cases where it has stood the empirical test of giving satisfaction to the user, and by researches conducted under actual working conditions. Its application is suggested in the first place by the logical expectation that it will destroy offensive odors in crowds, because it does this in the laboratory, and because this is in accordance with the theory of the chemical action of ozone.

Following the practical demonstration of satisfactory results from the employment of ozone, it was natural and proper that physiologists should have endeavored to demonstrate whether or not ozone were capable of harmfully affecting people exposed to its influence, and accordingly numerous attempts have been made to settle this question. The evidence to date is that no single instance of harm from the use of ozone in the quantities recommended has been published, but, on the contrary, numerous efforts to prove its harmfulness have been unsuccessful.

The writer has had considerable experience with ozone and has observed numerous co-workers who, with himself, have been exposed during five years to various concentrations of ozone, which, according to the authors above quoted, should have proven highly injurious if not fatal, but he has never noted the least ill effect from repeated and often prolonged exposures to these relatively high concentrations.

The bacteriological experiments referred to are of little or no interest, for two reasons: First, because they are in accordance with what is already well known; second, because sterilization of the atmosphere is not of any value whatever in sanitation.

Regarding the experiments with animals on which tracheotomy had been practiced, and into whose lungs ozone, in concentrations of from twenty to fifty times the concentrations recommended for ventilation purposes, had been directly introduced, we can say that the results might have been predicted, and that they have no bearing on the question of ozone in ventilation. Jordan and Carlson themselves point out that ozone, as used in ventilation, does not get into the lungs, but is absorbed in the nasal passages. They admit that it does not follow that, because strong concentrations of ozone are poisonous, weak concentrations are also poisonous, and further, they prove this to be the case in their experiments.

Referring to the efforts that were made to prove that ozone masks and does not destroy organic odors, it can be said that experiments carried on in a room such as Jordan and Carlson used, are subject to, at least, one great source of error, namely: Condensation and absorption on the walls and heterogeneous objects in the room. Bail has studied this and points out that after-odors may be referred to this cause. Czaplewski and also Van Kupffer have dwelt on this source of error. I have experimented personally and also have had tests conducted by others qualified to make precise observations, with what appears to be a more accurate method, namely: With clean glass bottles in which the surfaces could be washed free from adhering emanation, and the results have shown that organic odors generally are destroyed, and not masked by ozone.

Jordan and Carlson contend that the removal of odors is vicious as destroying an indicator of contaminated atmosphere, but, as is generally known, there are no poisons in vitiated air, and odor exists as odor alone and as such constitutes a nuisance whose destruction vouchsafes a most important function to ozone in ventilation.

It is conceded that bacteria in the air are of little or no importance in sanitation; that organic poisons do not exist; that odors are a nuisance. It has been shown that ozone removes these odors, and while it has been demonstrated that in strong concentrations ozone destroys these odors, many writers, including Jordan and Carlson, persist in the unsupported allegation, that in weak concentrations, ozone although admittedly banishing them, merely masks these odors.

Wide experience attests that ozone improves the condition of the air, and inasmuch as all attempts have failed to prove the least harmfulness of ozone when properly used, its utilization is as fully justified as is the use of such empirical remedies as, for instance, colchicum in gout.

MILTON W. FRANKLIN.

188 North Walnut St., East Orange, N. J.

Failure of Groined-Arch Roof, Belmont Filter, Philadelphia

A part of the groined-arch roof in Filter 14 of the Belmont Filtration Plant, which supplies water to the West Philadelphia section of the City of Philadelphia, Penn., collapsed early in the morning of Dec. 24, 1913. The filter was in service, but no one was near it at the time of the collapse and no damage was done except to the structure itself.

The Belmont Filtration Plant is part of the extensive water-purification system built in Philadelphia in 1901-04. It is located in the West Philadelphia district of the city and comprises roughing filters, sand filter beds and a clear-water basin. Fig. 1 shows in plan the layout of a part of the plant and particularly shows the location of filter beds Nos. 13, 14 and 15, in the middle one of which the failure occurred. The figure also shows the section through the two easterly bays of Filter 14, which section indicates the type of design employed.

Each of the three beds in question is of the nonreinforced concrete groined-arch roof type with the umbrellas resting on square posts, which in turn sit on an inverted groined-arch floor. The posts are spaced 15 ft. 3 in. c. to c. on squares. All dimensions are given in Fig. 1. Most of the filter beds in the Belmont plant have their floors resting directly on a solid bottom (a good clay) but the conformation of the surface forced the designers to place the larger part of the three filter beds in question on fill, which varied from 3 to 7 ft. in depth. Filter 14 is on the highest fill, the depth of which averaged about 5 ft.; this depth is fairly uniform throughout the whole extent of the bed.

Furthermore, it will be noted that the east line of these three filters is on a street, Monument Ave., the level of which is some feet lower than the base of the filters. It was necessary, therefore, to retain the fill on which these filters were built, by a cut-stone retaining wall, a section of which is shown in Fig. 1.

The construction of this part of the plant was carried out in 1902-03. The retaining-wall on Monument Ave. was first built and the fill placed next. After this fill had had a winter to settle, construction was started upon it. A preliminary layer of 12-in. of clay puddle (shown in Fig. 1) was first placed, and upon this puddle the concrete floor was directly laid.

The concrete construction was carried out according to the usual practice in groined-arch work, except that some of the posts carrying the arches were not cast in place, as is usual, but were cast, between the joints shown in Fig. 1, as separately molded members, and were set on the groined base with an intermediate mortar joint. On the top of this cast block the umbrellas were cast in place. There is evident in the collapsed portion a distinctly clean joint at both the bottom and top of the square section of these posts.

The roof was cast in place as a continuous structure north and south, but with a vertical construction joint at the end of the day's work at practically every crown line (north and south). There are evidences also that where time was not sufficient to complete a north-south bay, the day's work stopped on an east-west crown line, across the north-south bay, but the intention evidently was to make the general stopping line the north and south crown line.

The filters were completed in 1903, and water was let in during that year for tests. There are no records available as to indications of leakage found in the filter, either as observed by moisture showing on the wall on Monument Ave., or as evidenced by the variation in the water level, but there are some present indications that the retaining wall on Monument Ave. has been damp for some years.

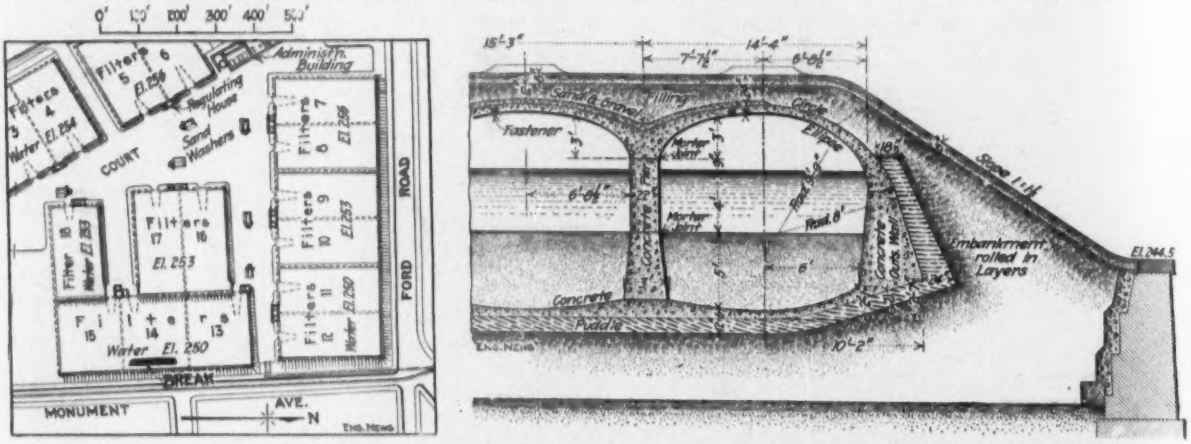


FIG. 1. PART PLAN OF BELMONT FILTRATION PLANT, PHILADELPHIA, AND EAST-WEST SECTION THROUGH EAST END OF FILTER 14

In 1904, cracks in the roof of the three filters (Nos. 13, 14 and 15) were noticed and a record was taken of them. The plan in Fig. 2 is practically a facsimile of a drawing made in December, 1904, showing the existence of cracks in Filter 14. It will be noted that these cracks are along the construction joint in the end bay of the filter on the east, north and west side. On the west and north side, however, the crack was small and the two parts of the concrete separated seem to be about at the same level. On the east side, which is the side next to Monument Ave., and the section through which is shown in Fig. 2, the cracking was more pronounced. Not only was there an opening, but the east side had lowered at the construction joint from ½ to 1 in. below the west side of the arch. In addition to the cracks along the

construction joint, a further crack appeared, as shown in the drawing, generally parallel to the construction-joint crack but near the haunch of the east overhang of the first line of groins. There is no record that the fill was moved from the top of the filters to make these measurements, so it is probable that they were made from below.

The condition shown in the drawing, Fig. 2, has continued since 1904 and the cracking along the side next to Monument Ave. has seriously increased. Nothing was done, however, until October, 1913, when a start was made toward a construction to support the easterly or end bay of Filters 14 and 15, which by that time had begun to show alarming cracks and displacement of the roof arch. As a preliminary to this repair work, timber struts were placed in the filter beds, footing on the filter sand, and carrying the overhang of the barrel arch, at the two lines of cracking shown on Fig. 2. The location of the struts is shown in the upper section of Fig. 3. At the same time, that is, in October, 1913, on Filters 14 and 15 the earth cover was stripped from the end bay from a point just about the eastern edge of the arch to a line just west of the first line of posts, and the earth taken from this area was thrown on top of the next adjoining (westerly) bay of groined arches.

The conditions then existing are shown in the upper section in Fig. 3. The stripping of the earth showed that considerable progress had taken place in the cracking at the lines of previous cracks. The openings were then wide and settlement of the arch had progressed until long sections were several inches out of line. Though not evidently continuous the size and length of the cracks were such as to warrant the use of the supporting struts. After the struts were placed, no further change in the cracking of the arch, or in the condition of the work in general, was noticed. Work was progressing toward the repair of the bay when a part of the end bay in Filter 14 collapsed on Dec. 24.

During the past summer a water main has been laid in a deep trench in the middle of Monument Ave. and in the course of the work some blasting has been resorted to in reaching the trench bottom. The excavation had proceeded from the north and at the time of the collapse was somewhat south of Filter 15, having passed Filter 14 some weeks before. No blast was set off on the morning of the collapse A similar trench had been dug along this street during the construction of the filters.

Fig. 3 shows in plan and in sectional elevation the conditions after the collapse. The photographs, Figs. 4 to 7, show different views of that collapse taken from points marked on the plan in Fig. 3. The area affected embraces groins extending northward from the southeasterly groin in Filter 14. As will be observed by the plan in Fig. 3, the parts which have fallen follow on the east side the line of the most westerly crack noted in 1904, except for a short distance in the middle of the filter, where the broken edge turns eastward and extends to the construction-joint crack, that is through the line of the crown of the barrel arch. The line of break follows north to within one bay of the northerly edge of the stripped fill, turns westward on an irregular line to the line of crown of the second bay (a construction joint) which is followed south for a few feet; the break then turns west to the west edge of the break which continues to the south end of the filter bed. This westerly line of break, it will be noted, bears the same relation to the second line of posts as the original westerly crack bore to the first line of posts. The earth fill is broken through on nearly a vertical line, as shown in Fig. 4, and from indications on Dec. 31 had then about 4 to 6 in. of frost in it. The lower section in Fig. 3 gives a typical east-west section through the break. It is not drawn to show precisely the location of any one set of groins, but gives the general disposition of the parts which have fallen.

Two of the posts supporting the groins are toppled over on the clean line of the lower mortar joint and are lying on the ground east of their former base. The remaining posts are inclined to the east, more or less, and are prevented from falling in most cases only by timber or con-

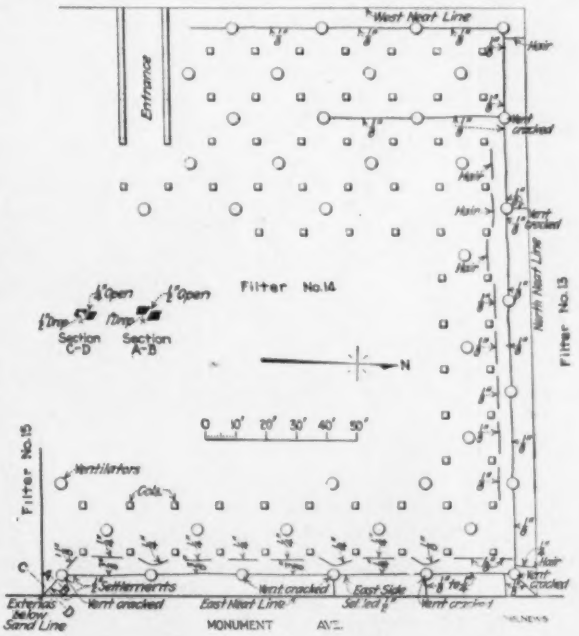


FIG. 2. PART PLAN OF FILTER 14 MADE IN DEC., 1904, SHOWING CRACKS THEN EXISTING IN ROOF

crete which is holding them up. The umbrellas are in every case either upside-down or nearly upside-down on the bottom and lie directly west or slightly southwest of their original location. The joint at the base of the umbrella is in every case clean (see Figs. 4 to 7). The concrete which overhung to the east on the second line of posts is lying under the fallen earth fill and in general up against the second line of posts. It is possible that the section of concrete marked *E* in the upper section in Fig. 3, is lying under the fallen earth fill, as shown in the lower section in Fig. 3, but at the time of writing this has not been uncovered, so the exact position of this part of the roof is not known.

The part of the roof *C* in Fig. 3 is supported entirely by the struts which had been placed last October, except in the middle section where for some reason these struts have fallen or were pushed over and the roof section has collapsed. There is also now a crack which appears to be of long standing, although there is no previous record of it, existing along the easterly haunch of the barrel arch, as shown in Fig. 3. The line of break at the barrel arch is clean and smooth, denoting a construction joint, as is also that part of the line of break following the

crown of the second bay, shown at the northerly end of the break. The other breaks are through the concrete and show a very hard, dense material, passing in most cases through the stone.

No measurements have been taken on the east wall to discover its possible settlement or leaning, but to the eye there is no variation in its line or grade. The filter sand has not been removed so the condition of the floor is not known. The second line of posts is very slightly disturbed; some posts are possibly ⅛ in. out of line at the top, to the east, but in general these are in good stable condition.

Filter 13 has not been stripped, but has the same cracks in it as were shown in 1904, although increased in size. Filter 15 has been stripped over the east bay, the same as was Filter 14 and is now in practically the same condition as was Filter 14 previous to its collapse. The cracks are about in the same position as those indicated for Filter 14, but are much wider and more distorted than they were in 1904.

Definite plans for the repair of the damaged filters have not been made, but in Filter 14 the last standing bay has been supported at the crown of the arch by struts and the next inside bay braced by inclined posts footing in the filter sand and butting against the slope of the arch.

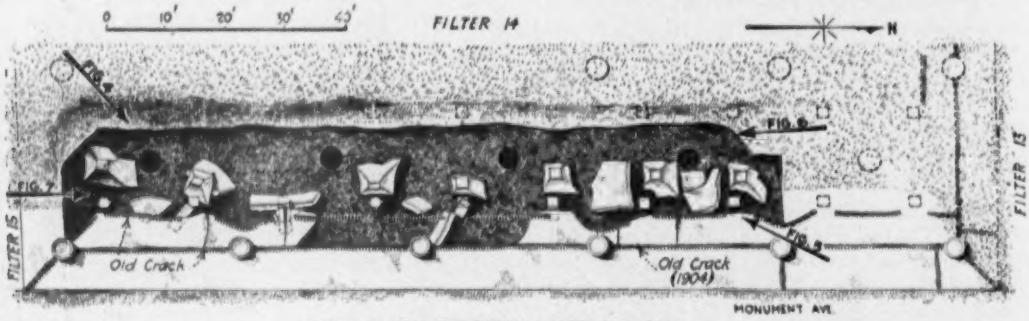
Presumable Causes of Collapse

The behavior of Filter 14 may be divided into three distinct phases: The occurrence of the original cracks, the growth of the cracks, and the disturbances due to moving of the earth in October last.

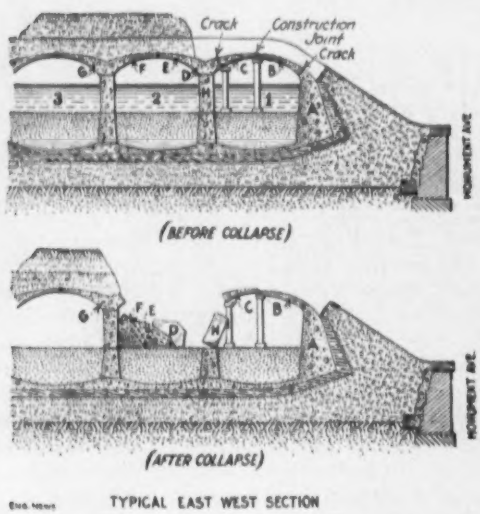
It is quite probable that the original cracks, first covered in 1904 and noted in the drawing in Fig. 2, due to temperature. The concrete was laid in the summer and during the following cold weather necessarily contracted, leaving openings along the line of least resistance, which is the construction joint at the crown of the arches. Filter 14 had these cracks along the crown joints at the end bays on three sides and also at a crown joint near the center of the roof. There were probably other cracks not visible at the time of examination, but the resistance on the end walls was less than the interior bays so that the cracks naturally occurred there. Such cracking is common in concrete groined arches.*

The secondary cracks noted in Fig. 2, that is, the cracking at the haunch line just outside the first line of posts, are undoubtedly due to cantilever action. When the crown crack opens sufficiently, the branch of the barrel arch and the adjoining branch of the groin are thrown into cantilever action. This action, while not strong enough to cause failure, did cause cracking clear through the thickness of the arch. As would be shown by an analysis of the section, the neutral axis of the section drops below the point of cracking and tension exists clear through the section there, which explains the opening on the underside of the floor. These cracks were not continuously large, so failure did not result and possibly some arch thrust was in action across the jutting projections at the cracks and across the hair-crack sections.

From 1904 to 1913 the cracks continued to increase materially on the east side of the filter, although the other cracks now do not seem to be any wider than they were when first noticed. This side differs from the other sides where crown cracks occurred, in that it is on a fill near a side slope. It is entirely probable that some settlement occurred on the east abutment wall, which naturally led to an increase in the cracks in the easterly end bays. This settlement may have been due to the original street excavation in Monument Ave., noted above, or it may have been due to some leakage through the filter bottom or side, which leakage would necessarily loosen up the fill to some extent. There is no direct evidence



PART OF EAST END, FILTER 14, AFTER COLLAPSE



ENG. NEWS TYPICAL EAST WEST SECTION

FIG. 3. DETAILS OF EAST END OF FILTER 14, SHOWING CONDITIONS BEFORE AND AFTER COLLAPSE, DEC. 24, 1913

*See article by Thos. H. Wiggin, Chief Designing Engineer, New York Board of Water Supply, "The Groined Arch in Filter and Covered Reservoir Construction," "Engineering News," Apr. 7, 1910, p. 399.

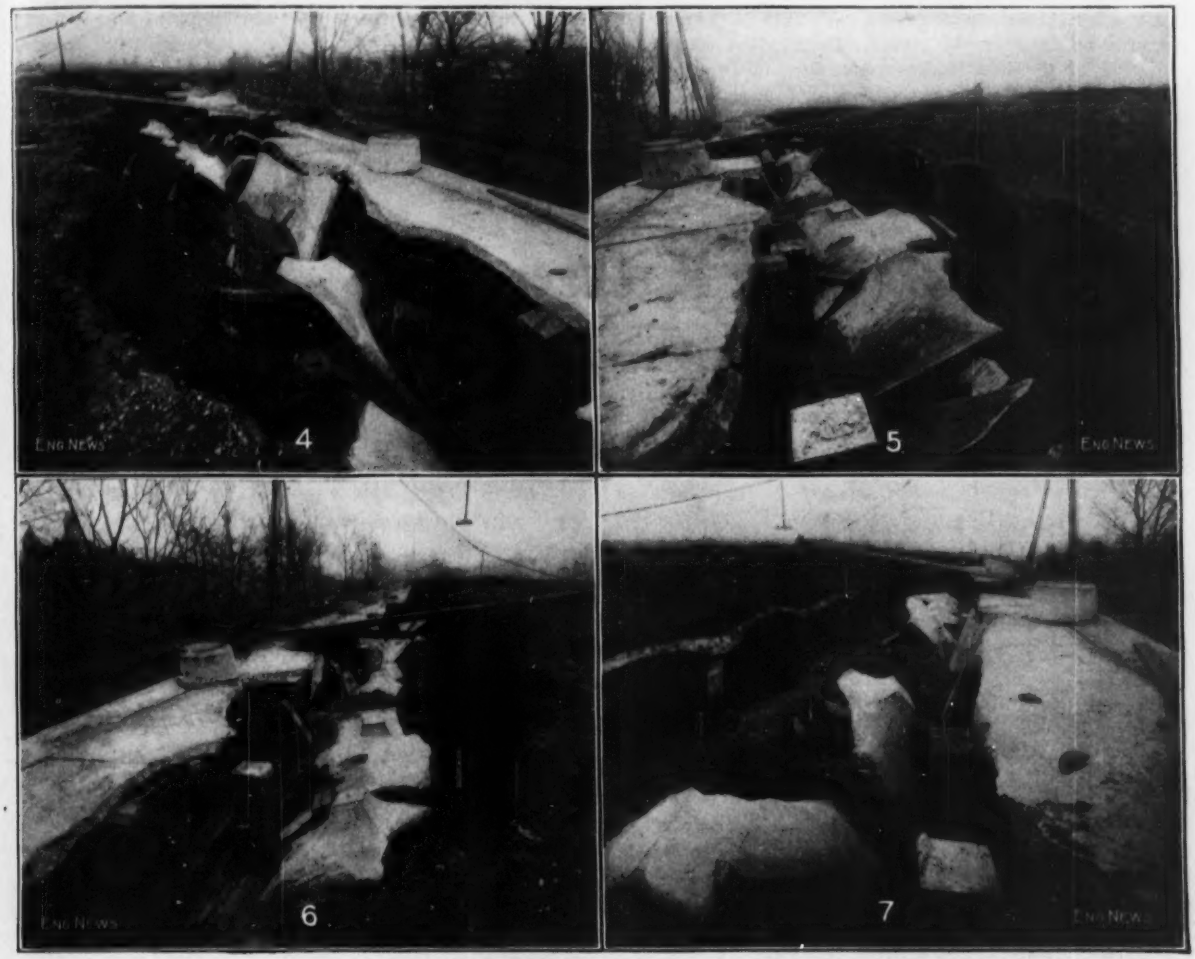
of any leakage, nor is there any evidence of a marked settlement of the fill at the side slope. However, this settlement must have been very small, for the amount of movement of the side wall was very small; had it been of any extent, the arch would have fallen many years ago.

After the removal of the earth fill over the east bay and the surcharge of the second bay, the conditions in the structure were different than they had been before. The behavior of the structure under the new conditions of loading is not perfectly obvious, mainly because of some doubts as to whether a groined-arch roof such as this acts as a series of arches transmitting load clear to the end abutment or as a series of independent umbrellas each carrying load as a cantilever. It is evident that the final break of most of the pieces which fell was due to the inability of the concrete to resist the moment of the weight of the overhanging piece, but the stress conditions immediately previous to the collapse are questionable.

The continuous-arch theory is about as follows: Previous to the removal of the earth fill over the end bay the thrust from the dead load and from the earth fill (the latter considerably diminished by its own arching action) was carried through the groins to the first line of posts and thence passed through the touching parts of the cracks at *C* and *B* down into the abutment *A*. After the removal of the earth from the end bay and its surcharge on the second bay, the thrust, increased by the surcharge (and possibly by the breaking of the arch action in the fill, due to the impact of the surcharge in placing), continued to the barrel arch as before, but the resistance of the earth fill over the end bay had been removed, so the thrust line was forced outside of the arch section; superinduced by the cracks already present, failure occurred just east of the first line of posts, and in plan at the middle of the break where (Fig. 3) slab *C* is down.

This slab once out, the umbrella *D* moved east sufficiently to open the second crown joint, which threw both umbrellas into cantilever action and the weaker failed first, the falling fill tearing down the other. It is probable that umbrella *D* overturned before it broke, because of its condition of unstable equilibrium.

The fault in the theory is that it does not explain why the second line of posts stood up when the first line of posts went down. Presumably if the arch thrust was sufficient to cause the failure of the first line of um-



FIGS. 4-7. VIEWS OF COLLAPSED PORTION OF FILTER 14, BELMONT FILTRATION PLANT, PHILADELPHIA
(Views taken from points indicated in the plan in Fig. 3)

brellas, due to the removal of the reaction of the earth fill, the same thrust would have been great enough to push over the second line of posts sufficiently to open the crown joint in the third bay, and the process of failure would have been continuous back to the other end of the filter. However, it may be that the earth above the westerly bays was frozen and did not transmit any load to the arch or that the thrust was carried in a lateral arch around the break.

The other theory assumes that after the first movement of the end arches and the opening of the end crown joint, the continuous arch action was superseded by an independent cantilever action of each line of north-south groins. So long as the earth was over the short east overhang of the first line of umbrellas, the overturning moment westward was not sufficient to upset the umbrella. A similar condition now possibly exists in the standing second line of umbrellas. After the load was removed from the east side of the first line and added as a surcharge on the west side, the umbrella was readily overturned, especially as the bond between umbrella and post was weak and the connection between sections *D* and *C* slight. The arm *F* necessarily broke off as a cantilever and the sections of slab *C* that fell were pulled down by shock or by the knocking out of their props.

An additional, though not generally held, theory of the initial break is that the shock of blasting in the street below loosened up the footings of the struts in the end bay and allowed that section of the roof between the two cracks to fall and the shock of the falling part overthrew the remainder of the collapsed part. Pockets have been known to form in the sand of the filter bed which would allow the dropping of a timber strut such as these supporting the roof in Filter 14. The action of the falling roof, however, subsequent to the collapse of this small part is due to the forces acting on the structure noted above, which forces would not be materially changed by the failure of the slab *C*.

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Drainage of the Everglades

SYNOPSIS—The problem of reclaiming the great area of the Florida Everglades by drainage is complicated by the fact that Lake Okeechobee (at the northern end of the region) receives flood waters from the north and these overflow southward into the Everglades region, thus overtaxing the drainage canals. The engineering commission whose report is abstracted below, proposes to lower the lake level by a short and direct canal to the sea. This will take care of flood waters, and leave the Everglades canal system to take care of the waters normally reaching that region. The canal would form part of a navigable waterway across the state and would provide water-power development.

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The Florida Everglades Engineering Commission was appointed in April, 1913, to investigate the problem of the drainage of the Everglades, and its report has recently been put at our disposal.* The Commission is composed of Isham Randolph (Chairman), of Chicago; Marshall O. Leighton, of Washington, and Edmund T. Perkins, of Chicago. Its report is made to the Board of Commissioners of the Everglades Drainage District and the Trustees of the Internal Improvement Fund of the State of Florida, constituted as follows: Hon. Park Trammell (ex-officio President), Governor of Florida; W. V. Knott, Comptroller; J. C. Luning, State Treasurer; T. F. West, Attorney General; and W. W. McRae, Commissioner of Agriculture.

In brief, the commission points out that Lake Okeechobee receives the drainage of a large watershed to the north and when its capacity is exceeded, this water overflows the lower edge of the basin of the lake and through the Everglades region. The remedies so far suggested (and partly undertaken) provide for the carrying off of the water from the lake by canals to the southward. The commission proposes instead to lower the lake level and take care of the drainage from the north by a 24-mile canal to the St. Lucie River and the Atlantic Ocean, thus relieving the lake and the southern system of drainage canals, and requiring less capacity for these canals.

The proposed Okeechobee-St. Lucie outlet canal, shown in the accompanying cut, would form a navigable waterway, and it is expected that the U. S. Government would consent to extend this westward from the lake to the Gulf by the Caloosahatchie route, thus completing a canal across the state. Further, the proposed canal would make possible the development of water power to the extent of about 5000 hp. which would be of special importance in a region having no mineral fuel and whose wood supply is diminishing. The report goes very fully into the questions of rainfall, runoff and evaporation in the district under investigation.

The conclusion presented by the Commission is that the drainage of the Everglades is entirely practicable and can be accomplished at a cost which the value of the reclaimed land will justify, the cost per acre being very small.

The solution of the Everglades drainage problem is dependent primarily on the disposition to be made of the flood waters entering Lake Okeechobee from the north. These flood waters under present conditions pass over the south rim of the lake and spread over the Everglades, placing that great area under servitude of the surplus waters of the northern watershed. The Everglades can best be relieved of this servitude by diverting the flood waters through a canal occupying the shortest practicable route to the Atlantic Ocean or an inlet thereof.

With these extraneous flood waters diverted, the problem of draining the Everglades is reduced to proper provision for carrying off the precipitation upon them. This can be accomplished by adding to the main canals which now traverse this territory (but which are surcharged with waters flowing out of Lake Okeechobee) other canals which are indicated on the map.

The St. Lucie Outlet Canal

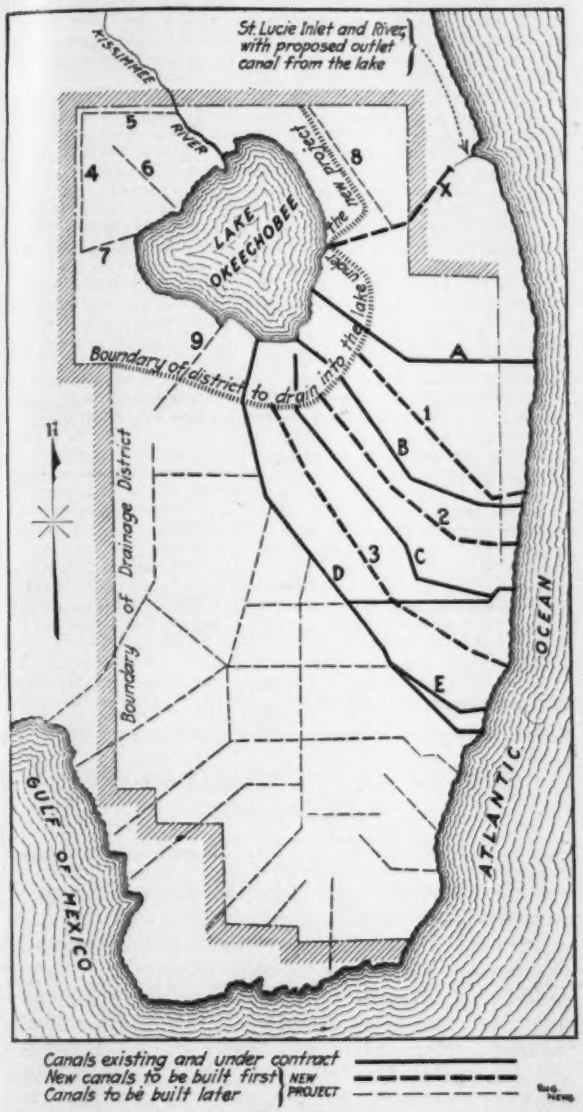
The canal from Lake Okeechobee to the St. Lucie River would be about 24 miles long, 200 ft. wide on the bottom, with 12 ft. of water. It is planned for a capacity of 5000 and 7000 cu.ft. per sec., at elevations 16 and 19, while the present canals when completed according to the plans will carry about 2600 cu.ft. at the latter ele-

*A report to the Everglade Land Sales Co., on the subject of the drainage of the Everglades was reviewed in our issue of Oct. 23. This report was made by a board of engineers composed of Daniel W. Mead (Madison, Wis.), Allen Hazen (New York) and Leonard Metcalf (Boston).

vation. The estimated cost is as follows: excavation for canal, $2,182,990; locks, $48,060; dams, $18,467; excavation for locks and dams, $9014; total, $2,259,000.

The whole cost of this canal should not be charged against the drainage of the Everglades, because this canal will serve three purposes: 1, to control the level of Lake Okeechobee for land drainage and flood storage; 2, to provide a 12-ft. navigable canal; 3, to afford a water power of primary capacity of 5000 hp., which will return to the Drainage District an income that will contribute largely toward the future maintenance of the drainage systems.

The total cost of this canal, lock system and power plant is estimated at $2,500,000. This investment charge should be divided approximately into three equal parts; one assessed against the drainage district, another against navigation, and the third to be bonded separately against the water-power plant. The water power will justify a bond issue of about $900,000, representing an investment of $180 per hp.


St. Lucie Inlet and River, with proposed outlet canal from the lake
KISSIMMEE RIVER
LAKE OKEECHOBEE
New Outlet
Boundary of district to drain into the lake
Boundary of Drainage District
ATLANTIC OCEAN
GULF OF MEXICO
Canals existing and under contract
New canals to be built first
Canals to be built later
NEW PROJECT

X. Proposed St. Lucie River outlet canal to lower the lake level and provide for flood waters.
1, 2, 3. Drainage canals to be built at once to supplement the present canals in the Everglades.
4 to 9. Canals to be built later to drain other sections of the district, the canals discharging into the lake.
The canals south of Canal D to be built as needed by the development of this section.

Present Canals.

A. West Palm Beach Canal, under contract.
B. Hillsborough Canal, under construction.
C. North New River Canal.
D. South New River Canal.
E. Miami Canal.

MAP OF THE CANAL SYSTEM FOR DRAINING THE FLORIDA EVERGLADES AND LOWERING LAKE OKEECHOBEE

DRAINAGE SOUTH OF LAKE OKEECHOBEE

Lake Okeechobee receives the floods from a watershed of 5366 sq.mi., and when its capacity is exceeded the waters spill over its southern edge and flow southward over an area of 4000 sq.mi. known as the Florida Everglades, stretching to the southern coast. The Three-Mile canal runs from the lake westward into the Caloosahatchie River. The Miami and North New River canals run to waters discharging into the Atlantic, and are connected by the east-and-west South New River Canal. There is shallow navigation in each canal, but a large amount of rock has to be excavated from the Miami canal to obtain the depth called for by the plans. A fourth canal, the Hillsborough Canal, is under construction; it has as yet no excavated outlet, but is discharging about 400 cu.ft. of water per second from the lake into the Everglades.

These canals, the initial part of a progressive drainage system, work on which is still progressing, under present conditions, even in so dry a season as that which has obtained for several months past, now serve to keep the Everglades wet because they are surcharged with Lake Okeechobee waters. This condition will not obtain when the whole project is carried out. The present canals, as a part of a broad comprehensive system, will be worth to the state every dollar that they have cost.

We have encountered an idea to the effect that the problem of draining the Everglades cannot be solved by progressive steps, but that the whole area must forthwith be covered by a great interdependent system of canals. We believe this to be an erroneous idea and that the Everglades can be reclaimed progressively, as is now planned, and that the work can so proceed as to reclaim the lands only as fast as there is need for them. We regard Lake Okeechobee as the key to the solution of the whole problem. When that great reservoir is brought under control and the territory to the south is freed from the overflow of the Lake, then the emancipated region can be relieved by adequate main drainage outlets and subsidiary canals whose capacities may be adjusted to meet the needs of the territory which they serve.

At present there have been excavated as main canals (that is, canals carrying the water of the drainage district and its watershed to some main body of water), the North New River, South New River and Miami canals. Those under construction are the Cypress Creek, Snake Creek, Snapper Creek and Hillsborough canals. Contract has been let for the West Palm Beach Canal. Until completed as planned, this system of main canals will not wholly accomplish the purpose of reclamation, but after the construction of the Lake Okeechobee-St. Lucie Canal, it will not be unreasonably expensive to so increase its capacity that it will suitably drain a major portion of the Drainage District.

The existing system of canals contemplates the reclamation of a greater portion of the Everglades in the immediate future than will probably be justified by the demand for new lands. It would have been better to provide for an orderly progression of reclamation in accordance with the demand and with due regard to market conditions and transportation facilities. The existing works and the conditions of land, ownership and settlement seem now to be such as to necessitate an earnest effort to reclaim in one continuous project and with the greatest possible expedition, all the lands southeast of Lake Okeechobee, between the Miami Canal, the proposed West Palm Beach Canal and the eastern boundary of the drainage district.

To meet this last named requirement, the proposed scheme provides for supplementary canals, Nos. 1, 2 and 3; the enlargement of present canals *A* to *E* (see map) and the placing of locks in these latter canals. The cost of this work is shown in Table I. An additional system of canals farther south is shown on the map, and the cost of this (as well as of proposed canals in the north) is shown in Table II.

OTHER DRAINAGE CANALS—The Allapattah Flats in the northeast corner of the Drainage District are to be drained by a canal (No. 8 on the map) running from the northern edge of the District to the St. Lucie outlet canal. The northwest corner of the District beyond Lake Okeechobee presents an isolated problem and is an illustration of the fact that it is possible to economically drain fractional portions of the Everglades. This is to be served by canals Nos. 4 to 7. As

TABLE I. WORK TO BE UNDERTAKEN FIRST

Canal	Length miles	Area drained sq.miles	Excavation 1000 cu.yd.	Cost
1	33	340	7078	$637,000
2	42	242	7844	784,000
3	61	429	15,510	1,551,000
Total	136	1011	30,432	2,972,000
Enlarging A, B, C, D and E	255	1084	9972	1,207,200
			Four locks	101,400
Total	391	2095	40,400	$4,281,000

Unit cost for excavation; No. 1, 9c.; Nos. 2 and 3, 10c.; enlargements, 10 and 12½c.

Cost per acre, $3.20 above present expenditures.

TABLE II. FUTURE DRAINAGE CANALS

Canal	Length miles	Area drained sq.miles	Excavation 1000 cu.yd.	Cost
		Northwest		
4	24	50	2,565	.....
5	16	49	1,625	.....
6	14½	197	3,704	.....
7	9½	.....	4,013	.....
Total	63	296	1,1907	$714,000
		Northeast		
8	23½	195	6,188	$372,000
		West		
9	12	106	2,500	$150,000
		South		
	330	2907	73,148	$14,630,000
Grand total	428	3504	.....	$15,866,000

Unit cost of excavation: Northwest, 6c.; South, 20c.

Cost per acre: Northwest, $4.27; Northeast, $3.51; West, $2.76; South, $7.92. These costs include the share for the St. Lucie outlet canal.

the lands are reclaimed, settled and cultivated, it will be necessary to extend the canal system to the west and south.

By the above mentioned locks and the construction of the canal marked No. 9 on the map, there will be turned into Lake Okeechobee from the South and East the drainage of 500 sq.miles.

AUXILIARY FEATURES OF THE REPORT

KISSIMMEE VALLEY DRAINAGE—The commission was requested to consider the effect of the proposed lowering of Lake Okeechobee upon the problem of draining the lands in the Kissimmee Valley (north of the lake), and its conclusion is that the successful reclamation of these lands is dependent upon the lowering of the lake as contemplated by the present project. This will lower the mouth of the river, giving a greater slope and greater velocity.

A former report on a 3-ft. navigation system has recommended that if the lake is lowered, a lock should be placed at the mouth of the Kissimmee River to maintain the water in the river at the same elevation as now exists during low-water stages in the lake. The commission points out that this would prevent the improvement of over a million acres of rich land, a feature not warranted by the establishment of a 3-ft. navigation in the river.

MAINTENANCE OF CANALS—The permanent maintenance of the canals at their full carrying capacity is highly important, especially in view of the character of material favorable to the sloughing of the banks, the silting of the channel and the growth of weeds. For this reason, laws and regulations governing the administration of the drainage district should contain strict provision for canal maintenance. Each farmer should be required to maintain the lateral ditches. For the larger canals, the tax levy should provide for maintenance under the control of the district.

EXCAVATION—For excavating the muck, sand and softer soils, the commission knows of no excavator which will give more economical results than the hydraulic dredge, with the dipper dredge for excavating rock under water, and a drill scow for submarine blasting. Where (as in this work) the volume of work justifies the investment of the owner or agent in the necessary equipment and the employment of a competent manager and employees, the owner can prosecute a work of this magnitude at a less cost than that at which it is likely to be done by contract. As soon as the work is staked out, a dipper dredge (with boom of sufficient length) should build a levee along the outer edge of each berm to hold back the material delivered by the hydraulic dredge.

WATER POWER—The St. Louis outlet canal, with the recommended grade of 0.2 ft. per mile, will have a fall of only 4.9 ft., while the total fall from the lowest permissible stage of the lake to the ordinary stage of the St. Lucie River is 15.7 ft. The minimum flow of 5000 cu.ft. per sec. with a fall of 10.8 ft. will yield (at 80% efficiency) 4907 net electrical horsepower. At the high stage of the lake this would reach a maximum of 6270 hp. The cost of hydro-electric equipment and power house will be about $210,000. A smaller canal with a grade of 0.5 ft. per mile would carry the same volume and cost about $200,000 less, so that the total cost for the water-power plant would be $410,000, or $82 per hp.

In the south Florida region, where power will be in increasing demand for commercial and household purposes, for pumping water for irrigation, and (in the earlier periods) for operating dredges in interior drainage operations, this power will surely find a profitable market. Present and prospective cost of fuel in that region is high; therefore power derived from fuel will also be of large cost. A gross average selling price of $40 per hp.-year for 24-hr. power is conservative under prevailing conditions. Thus there is promised an annual income of $200,000, which, however, does not include the possible increase in actual sales equivalent to 40 or 50% in excess of actual plant capacity, which is made possible by the fact that consumers do not use power continuously at the same periods of the day.

Fixed charges against this plant, exclusive of transmission system, will not exceed 10% on the investment or $90,000 annually. The residue of the annual gross income $110,000, plus the excess above referred to, should care for all operative charges and leave a generous balance which can be applied to future drainage district maintenance.

NAVIGATION—The St. Lucie Canal will have a depth of 12 ft. and a bottom width of 200 ft. At 24 miles from the lake it will discharge into the St. Lucie River, and here would be a lock 30x130 ft. Congress has accepted a project for the improvement of the St. Lucie inlet and the commission believes that Congress will recognize the canal as a link in a waterway across Florida, provided without cost to the U. S. Government, and will proceed to improve the channel to the Gulf by the Caloosahatchie River.

LOCKS—The locks in the four canals now existing or under construction would be 5 ft. narrower than the St. Lucie River lock. It is proposed to build these locks in caissons, the caissons (with work commenced) being floated into position over foundations previously prepared, and there sunk. The foundations will be of piles with rock filling around the pile heads. The miter sills will be of white oak and the gates of cypress, long-leaf yellow-pine or Douglas fir.

It is not considered necessary to provide a single channel large enough to carry the maximum flood that may occur, but under such conditions the commission advises the temporary use of all the canals leading out of Lake Okeechobee. To accomplish this, stop logs would be placed at the downstream end of the lock to raise the head in the lock to the upstream level. Then the gates would be opened and secured, and the stop logs removed to give a free flow through the lock. When the emergency is over, the stop logs would be replaced temporarily to make it possible to close the gates.

Notes From Engineering Schools

HARVARD AND "MASSACHUSETTS TECH."—An agreement has been reached to combine the engineering departments of Harvard University with the Massachusetts Institute of Technology, to take effect when the new buildings of the latter are completed. The present professors of mechanical, electrical, civil, sanitary and mining engineering and of metallurgy in each institution will combine to form the engineering faculty of both. Students may register as either Harvard or Tech. men or as both, and they may receive their degrees from either or both instutions. This arrangement is subject, however, to the requirements now existing which make engineering a post-graduate study at Harvard and both undergraduate and postgraduate at M. I. T.

Each institution maintains its identity, being "absolutely unaffected in name, organization, and in title to property." The Institute of Technology will furnish buildings, laboratories, equipment and all its funds assigned to the Departments mentioned. Harvard gives the funds and equipment now belonging to the Lawrence Scientific School for education and research and at least three-fifths of the Gordon McKay Endowment. The president of Technology becomes the executive director of the work, and when future presidents are selected the President of Harvard will sit with the Technology

committee on selection. The agreement may be terminated by either party on five years' notice or sooner by mutual agreement.

STEVENS INSTITUTE OF TECHNOLOGY—A discussion on "The Engineer's Part in the Regulation of Public Utilities" was held at Stevens Institute in Hoboken, N. J., on Jan. 9, as a part of a "Stevens Convention."

The first speaker was President A. C. Humphreys, who reported finding three typical attitudes of public-utility officials in combating the misleading impressions generally given the public of their concerns. One was aggressive defense against unjust commission and court decisions; another was meek submission to all such orders which gave the public every impression of truth in the allegations; the third was attempt at educating the public to better knowledge of all the affairs of the utility company. He cited some of the errors of utility commissions which had disturbed him and argued that great improvement could be expected with an adequate number of engineers on all regulating bodies. This benefit would come not merely because they were engineers and only if they had proper administrative ability and practical experience.

George Gibbs, Consulting Electrical Engineer of the Pennsylvania R.R., in some contributed remarks, expressed some more definite doubts about having engineers as commissioners. He placed administrative abilities first in importance with previous specialized training secondary. He was afraid that the administrative work would keep an engineer out of touch with technical development and so lead to errors of judgment in technical matters; a permanent engineering staff, not burdened with administration, might do better work.

J. W. Lieb, Jr., Vice-President of the New York Edison Co., described utility regulation as one of two important movements in this country—one looking to the improvement of rural life and the other to the benefit of city dwellers. Protection to life and property was a municipal function—hence fire and police, and usually water-supply, services were departments of local government. The other agencies making for convenience and comfort, like gas and electricity supplies, telephone and transportation services, etc., were usually and reasonably private enterprises under some form of public supervision. Engineers created the conditions which had to be regulated and they should be able to handle the supervision more intelligently than self-styled "statesmen," petty politicians, and men versed only in law.

Jas. E. Sague, Member of the Public Service Commission for the Second District of New York, first noted that corporations were creatures of the State and hence logically subject to regulation. The corporations, on the other hand, were effective tools and study of them should not be delegated by engineers to politicians. Regulation would die if the enthusiasm of corporation men in work well done should not be preserved; the present influence of state bodies he felt was not in that direction.

NEWS NOTES

A Wrecked Flatboat in the Fraser River, B. C., according to a press dispatch dated Jan. 6, caused the death of 75 laborers of the Grand Trunk Pacific Co., who were being transported across the river. The boat, carrying 100 men, became unmanagable and was wrecked on the rocks.

An Explosion occurred on the German tank steamer "Geestermunde," bound from Baton Rouge, La., for Tampico, Mexico, in the harbor of New Orleans, La., on Jan. 5. A hole 100 ft. long was torn in the deck, and the ship was set afire, when 3000 gal. of oil in the port tanks blew up.

No Bids for the comprehensive system of passenger subway rapid-transit lines authorized by the City Council of Chicago, were received on Jan. 5, when bids were to have been opened. The proposed work, as noted in "Engineering News," Nov. 20, 1913, page 1044, covers approximately 57 miles of route, or 135 miles of single track, costing $96,000,000 for subway construction and $34,000,000 for equipment. The nearest approach to a bid was an offer from W. H. Brown Construction Co., of London, offering to bid. Failure to attract bids is attributed to legislative handicaps, since the city cannot grant a franchise to exceed 20 years, and this must include the period of construction, from 3 to 5 years.

A Railway Collision between a freight train on the Nashville, Chattanooga & St. Louis Ry. and a street car in the southern outskirts of Memphis, Tenn., on Jan. 4, caused the death of five persons and the injury of several. The freight train was operating on a track which the city officials several days before the accident had ordered the railroad to remove. As the order had not been complied with, the Mayor, E. H. Crump, and Thomas Dies, Commissioner of Public Utilities, with a force of men, on Jan. 5, tore up the railroad track at the grade crossing where the collision had occurred.

A Six-Mile Long Railway Tunnel through the Continental divide, 50 miles west of Denver, is projected by the Denver & Salt Lake R.R. Co., which has asked the city of Denver to vote a bond issue of $3,000,000 in aid of the project. The vote will take place in February. A report upon the proposed tunnel has been made by a board of engineers, consisting of Messrs. J. Vipond Davies, of New York City, E. W. Brunton and J. Wellington Finch, of Denver. They estimate the total cost of the tunnel as $4,420,000, its length being 6.03 miles. The time required for construction is set at four years. The tunnel is to be driven at an elevation of about 9100 ft. above sea level, and was originally projected as part of the Denver, Northwestern & Pacific Ry. built by the late D. M. Moffat.

Under the contract between the railway company and the city of Denver, the tunnel is to be driven with a cross-section large enough so that the city can lay a conduit through it for increasing the city's water-supply. In addition, the railway company agrees to permit any other railway to use the tunnel and its approaches on reasonable terms for trackage rights and payment of half the interest on the investment in the tunnel. The railroad company has the option of purchasing the tunnel by paying to the city the face value of its bonds with accrued interest. The city retains a perpetual right, however, to the use of its aqueduct and conduits for electric wiring passing through the tunnel.

A Unique Power Plant has been designed for the Ford Motor Co., of Detroit, Mich., to cost in the neighborhood of $1,000,000. The existing power plant of the company is notable as having the largest producer-gas engine in the country. This is a 5300-hp. machine of the twin tandem type, having four double-acting cylinders, 42x72 in. The machine was designed by the mechanical engineer of the Ford company, Edward Gray, and has several features of note. For instance, there is no bedplate, but the cylinders are held in line on the foundation with provision for movements under load and temperature strains. The engine drives a 2500-kw. generator.

The new station will have four 6000-hp. engines of somewhat similar type (known as the "Hamilton-Gray") driving four 3750-kw., 250-volt, engine-type, direct-current generators at 80 r.p.m. There will be one important modification in the engine design, however. Instead of two gas cylinders in tandem on each side of the generator, there will be two gas cylinders on one side and two steam cylinders on the other. Steam will be generated from the water used in the water jackets of the gas-engine cylinder which will be further heated by the exhaust gases from the engine and the waste heat from the gas producers, a final addition of heat may perhaps be made in a steam boiler or superheater of the usual type. The torque characteristics of the diverse elements of this design will be equalized by a heavy flywheel.

The generators themselves are of interest in being the largest reported for such service. They are designed for 94.5% efficiency at full load, which is claimed to be somewhat higher than ordinarily found in practice with this type. The armatures are to be split for shipment on account of clearance requirements of tunnels and bridges, and the generators will be assembled at the Ford plant. They are being designed and built by the Crocker-Wheeler Co., of Ampere, N. J.

Progress on the Catskill Water-Supply, New York City

The last portion of the city tunnel of the Catskill Aqueduct was holed through with proper ceremony on Jan. 12. The blast electrically fired on that occasion by Mayor Mitchell completed the bore of the 18 miles of deep pressure tunnel beneath New York City and left no barrier in the 110 miles of aqueduct between the Ashokon Dam in the Catskill Mountains and the terminal shafts in Brooklyn.

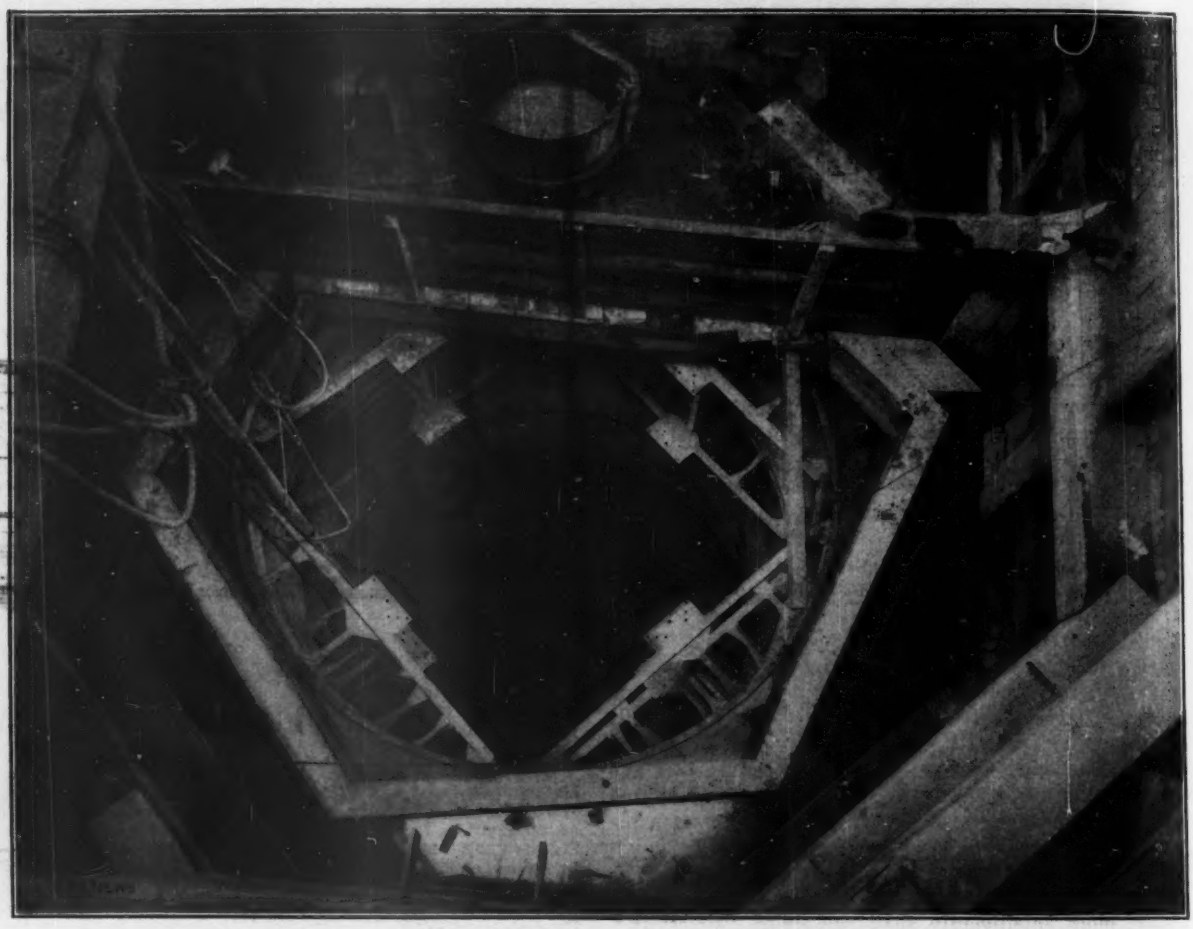


FIG. 1. LOOKING DOWN SHAFT 9 OF THE CITY TUNNEL, CATSKILL AQUEDUCT, NEW YORK CITY

(The hexagonal concrete water stop around the top of the shaft prevents surface water from running down the shaft by diverting the water through the chamber drain to the sewer. The concrete mixing plant is just above the limits of the view. The bucket, on the platform, is directly under the chute which leads from the mixer. This shaft is on St. Nicholas Ave., between 149th and 150th Sts., on Contract 65, held by the Pittsburgh Contracting Co., and is on the section officially holed through on Jan. 12, 1913. The view here reproduced was taken on Nov. 27, 1911, a few months after the work was begun.)

The city tunnel of the Catskill Aqueduct begins at the Hillview Reservoir near the Yonkers-New York line, passes under Bronx Borough, the Harlem River, Manhattan Borough, the East River and on to the two terminal shafts in the Borough of Manhattan. It ranges from 15 to 11 ft. in diameter, is lined with concrete and lies from approximately 200 to 750 ft. beneath the surface of the ground. It was driven and is being lined from 24 shafts, in which will be erected and surrounded with concrete the uptake pipes for connection with the water-distribution system of New York City.

The city tunnel work was divided into four contract sections. Bids were received on May 16, 1911; contracts were let on June 1 and 7 and construction begun on June 5, 12 and 15.

The location, length, inside diameter, contractor and contract-award price for each of the four contract sections were as follows:

Contract 63: From 187 ft. north of city line to Aqueduct and Burnside Avenues, 4 miles. Diameter, 15 ft. Mason & Hanger, Van Cortland Park, New York City. $3,709,372.

Contract 65: 5.4 miles, from Aqueduct and Burnside Avenues to Central Park, near 8th Ave. and W. 99th St., 5.4 miles. Diameter, 15 ft. for 17,700 ft. and 14 ft. for 10,600 ft. Pittsburgh Contracting Co. (Booth & Flinn), 1942 Forbes Ave., Pittsburgh, Penn. $5,590,225.

Contract 66: Central Park at 99th St. to Union Square at 14th St., 4.4 miles. Diameter, 14 ft. for 15,600 ft., 13 ft. for 4500 ft. and 12 ft. for 3000 ft. Grant Smith & Co. and Locher, Rome, N. Y., and 25 W. 42d St., New York City, $4,512,605.

Contract 67: From Union Square to 3d Ave. and Schermerhorn St., Brooklyn, 4 miles. Diameter, 12 ft. for 6100 ft. and 11 ft. for 15,000 ft. Holbrook, Cabot & Rollins Corporation, Geo. B. Fry and Thos. B. Bryson, 331 Madison Ave., New York City, $5,727,435.

About 3000 ft. of 15 ft. tunnel at the northerly end, not included above, was embraced in the Hill View Reservoir Contract, held by the Keystone Construction Co., of Pittsburgh, Penn., and 2 Rector St., New York City.

The final holing through last Monday was on Contract 65 (Pittsburgh Contracting Co.). Invitations to the ceremony gave as the meeting place Shaft 9, at St. Nicholas Ave. and 150th St. (see Fig. 1). On this contract section about three-fifths of the invert has been placed and some 7000 ft. of concrete lining has been sub-

stantially completed (see Fig. 2 for view of lining work in progress).

The Catskill water-supply project includes, besides the aqueduct proper and the city tunnel, the following elements: The Ashokan Reservoir, of 128 billion gallons available capacity, formed by the Olive Bridge Dam and several dikes, at the head of the aqueduct; the Kensico Reservoir, of 29 billions available capacity, 77 miles below the Ashokan Reservoir and 30 miles from the City Hall, designed to furnish storage near the city; the Hillview Reservoir, of 900 million gallons capacity, near the city line, designed to equalize the difference between the steady flow of the aqueduct and the varying rise of water in the city; steel and cast-iron extensions from the Brooklyn terminal shafts of the city tunnel, one of which (cast-iron) will extend beneath the Narrows to Staten Island (Richmond Borough); and the Silver Lake Reservoir on Staten Island, of 400 million gallons capacity.

The Catskill Aqueduct has a nominal capacity of 500 million gallons a day. For the present it will be fed from the drainage area (255 sq.mi.) of Esopus Creek, only, which has a dependable yield of a 250,000,000 gal. Later connections with adjacent drainage areas will command a total drainage area of nearly 900 sq.mi., which is estimated to yield 770,000,000 gal. a day in a series of extraordinarily dry years.

Remarkable progress has been made with the construction of the whole Catskill water-supply system. The Board of Water Supply was appointed on June 9, 1905. The first contract was dated Apr. 10, 1907, and work under it was begun six days later. The city-tunnel plan for delivering water to all the boroughs was finally approved by the Board of Estimate on July 1, 1910, and construction on this work was begun in June, 1911, as already stated.

At the present time the Olive Bridge Dam is nearly completed, but it will take until into 1915 to clean up everything connected with the Ashokan Reservoir, formed by this dam. However, water has been stored in this reservoir to a height of 540 ft. above sea level, and is now at 510 ft., as compared with Elev. 590 for full-water level in the west basin, and Elev. 400 for the bed of Esopus Creek just above the dam.

The 92 miles of aqueduct proper is practically completed. If needed, water could be turned, by gravity, from the Catskill Aqueduct into the Croton Reservoir during the coming spring. By the end of 1915, or early in 1916, it is probable that water can be delivered to the city through the city pressure tunnels.

The Hillview Reservoir is about three-fourths done and probably will be completed by the end of 1915. The Kensico Reservoir is about 40% done. It can be put into

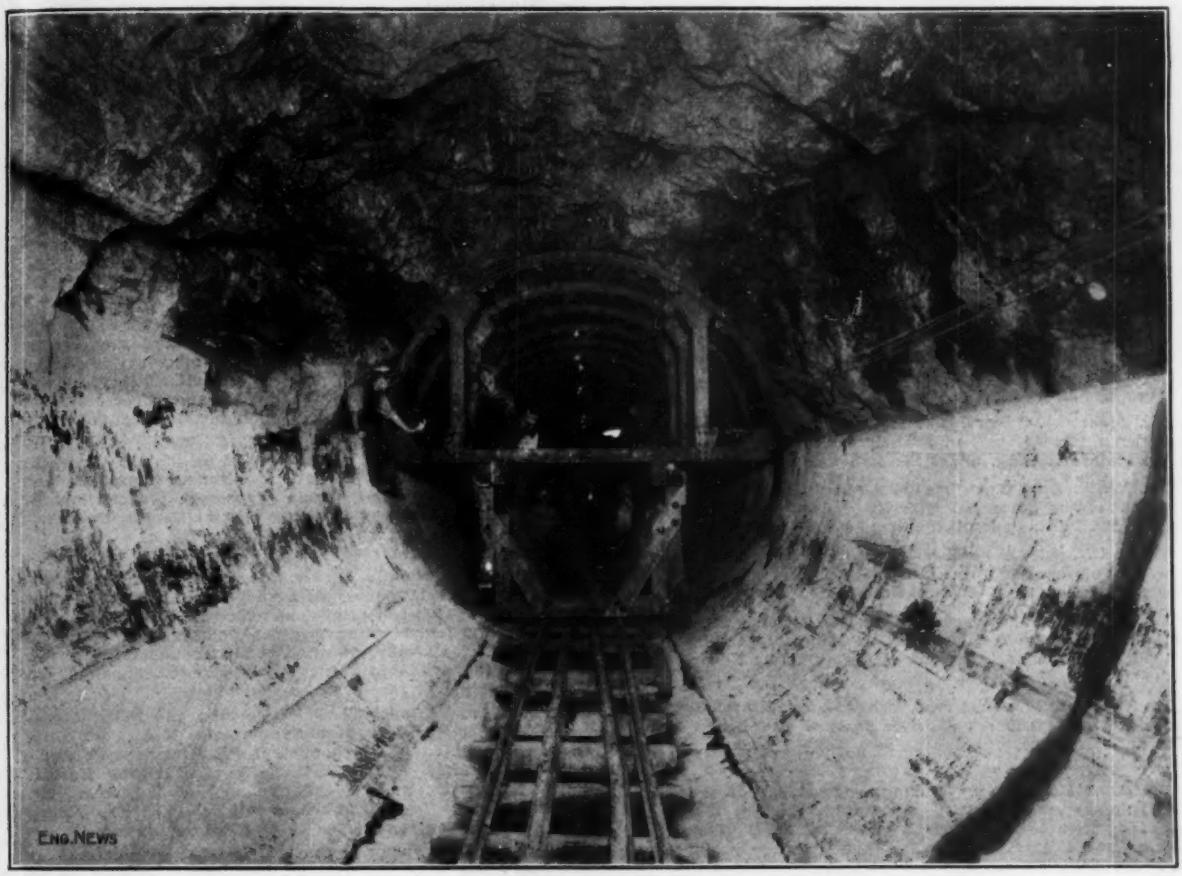


FIG. 2. LINING THE CITY TUNNEL, CATSKILL AQUEDUCT

(Completed invert, sidewalls and construction track in foreground and steel arch forms in background. The view was taken on Aug. 19, 1913, near Shaft 10 on Contract 65.)

use for a part of its storage depth by 1915, but the contract does not call for completion until some five years later.

The Silver Lake Reservoir contract was let only a few months ago. The contract for the Narrows Crossing is being advertised, bids to be received on Jan. 27. Aside from buildings and various equipment items the only parts of the Catskill water-supply system not yet contracted for or advertised are the pipe line on Staten Island and a short length of steel pipe in Brooklyn.

J. Waldo Smith is chief engineer and Merritt H. Smith deputy chief of the Board of Water Supply; Alfred D. Flinn is department engineer of Headquarters Department; and Walter E. Spear is department engineer for the City Aqueduct, including all the construction within the city.

PERSONALS

Mr. George Rommel, Jr., M. Am. Soc. C. E., has resigned as City Engineer of Pensacola, Fla.

Robert C. Hicks, General Inspector in the Department of Public Works, Philadelphia, Penn., has resigned.

Mr. J. W. Butts, Trainmaster of the Missouri, Kansas & Texas Ry., at Greenville, Tex., has been promoted to be Superintendent at Greenville.

Mr. T. Nicholson has been appointed Master Mechanic of the Louisiana Ry. & Navigation Co., at Shreveport, La., succeeding Mr. M. F. McCara, resigned.

Mr. Albert W. Burgren has resigned from the firm of Ross & Burgren, Architects, San Francisco, Calif., to open an office in the Holbrook Bldg. under his own name.

Mr. W. H. De France has been appointed Division Superintendent of the Texas & Pacific Ry. at New Orleans, La., succeeding Mr. N. G. Pearsall, assigned to other duties.

Mr. C. D. Ashmore has been promoted from the position of General Foreman at Clinton, Iowa, to that of Master Mechanic of the Chicago & Northwestern Ry., at Pekin, Ill.

Mr. John K. Fahey, recently Assistant Superintendent of Morgan's Louisiana & Texas R.R. & Steamship Co., has been promoted to be Superintendent of Terminals at New Orleans, La.

Mr. George P. Turner has been appointed Assistant Engineer, Office of the Special Engineer of the Union Pacific R.R., and assigned to valuation work with headquarters at Omaha, Neb.

Mr. B. C. Mulhern, recently Superintendent of the Pittsburgh, Shawmut & Northern Ry., at St. Marys, Penn., has been promoted to be General Superintendent, with headquarters at St. Marys.

Mr. Thomas Schoenlaub, who has been acting Superintendent of Maintenance in Division 3, New York State Highway Department at Watertown, N. Y., has been promoted to be Resident Engineer at Watertown.

Mr. Robert Swan, the new Chief of the Department of Public Works of Pittsburgh, Penn., is an engineer. He graduated in civil engineering from the University of Pittsburgh, then called the Western University of Pennsylvania, in 1879.

Mr. B. F. Wood, M. Am. Inst. E. E., formerly Assistant Engineer, motive-power department of the Pennsylvania R.R., at Altoona, Penn. has been appointed Chief Engineer of the United Gas & Electric Engineering Corporation, New York City.

Mr. J. A. Griffin, Assoc. M. Am. Soc. C. E., for a number of years connected with the construction department of the Southern Ry. as Assistant Engineer, has been appointed Engineer of Maintenance-of-way of the Georgia & Florida Ry., Augusta, Ga.

Mr. C. W. Raynor, Assoc. M. Am. Soc. C. E., has resigned as Chief Engineer of the Coast Bridge Co., Portland, Ore., to enter private practice as Consulting Engineer, specializing in hard surface road and bridge construction, with offices in the Spalding Bldg., Portland.

Mr. W. D. Scott, General Superintendent of the Great Northern Ry., Seattle, Wash., has been appointed General Superintendent of the Spokane, Portland & Seattle and Oregon Trunk Rys., with headquarters at Portland, Ore., succeeding Mr. J. Russell, resigned.

Messrs. H. F. J. Porter, M. Am. Soc. M. E., and A. L. Himmelwright, M. Am. Soc. C. E., announce their association for the practice of engineering, specializing in problems involving the safety to life in buildings, with offices in the Masonic Hall Bldg., 23rd St. and Sixth Ave., New York City.

Mr. Arthur C. Toner, Assoc. M. Am. Soc. C. E., whose resignation as Assistant Engineer of the Baltimore Sewerage Commission was noted in our issue of Dec. 25, 1913, has been appointed Engineer of the Association of American Portland Cement Manufacturers, with offices in Philadelphia, Penn.

Mr. Thomas C. Atwood, M. Am. Soc. C. E., formerly Division Engineer, Department of Gas, Water Supply & Electricity of the City of New York, has accepted the position of Construction Manager of the new reinforced-concrete amphitheater for the athletic field of Yale University, New Haven, Conn.

Mr. A. Vernon Orner, Civil and Mining Engineer, recently with the firm of Hess & Bouton, Engineers, Du Bois, Penn., has been appointed Chief Engineer and Superintendent of the Panther Run Coal Co., Pardus, Jefferson County, Penn., succeeding Mr. Henry Redding, who has retired after 11 years service with the company.

Mr. Benjamin McKee, Jr., recently appointed City Engineer of Warren, Ohio, has found his predecessor, Mr. B. C. Smith, disinclined to relinquish the office. Mr. Smith holds that he cannot be removed, under the civil-service laws, except for cause. It is reported the case wil be taken to the State Attorney General for a ruling.

Mr. Frank E. Pratt, M. Am. Soc. C. E., for the past nine years Chief Engineer for Arbuckle Bros. and the Jay St. Terminal, Brooklyn, N. Y., has opened an office at 150 Nassau St., New York City, for the practice of civil engineering and architecture, specializing in the design and construction of docks, railways, buildings, etc., for industrial plants.

Mr. Henry C. Allen, M. Am. Soc. C. E., until recently City Engineer of Syracuse, N. Y., has opened an office in Syracuse as Consulting Engineer. He will also act as Consulting and Chief Engineer of the Grade Crossing Commission of Syracuse. Mr. Allen was formerly Special Deputy State Engineer on the New York Barge Canal. He had been City Engineer of Syracuse since 1907.

Mr. Charles A. Hoppin, M. Am. Soc. M. E., General Superintendent of the electric and heating departments of the Peoria Gas & Electric Co., has opened an office in Peoria, Ill., as a Consulting and Constructing Engineer, making a specialty of the construction and operation of steam-electric power plants, heating and ventilating systems and mechanical and electrical equipment for factories and mines.

Mr. William E. Copeland, Chief Chemist and Bateriologist of the Metropolitan Sewerage Commission, New York City, has been appointed Chief Chemist of the Sewerage Commission of Milwaukee, Wis., of which Mr. T. Chalkley Hatton, M. Am. Soc. C. E., was recently made Chief Engineer. Mr. Copeland will go to Milwaukee about Feb. 15. The salary of his new position is reported to be $3600 per annum.

Mr. Charles T. Fisher, recently Assistant Engineer, New York State Highway Department, has been promoted to be Resident Engineer in the Second division at Albany, N. Y. Mr. Fisher graduated from the Worcester Polytechnic Institute in civil engineering in 1901, and has been with the Northern Pacific Ry., the New York State Barge Canal, and since 1906, with the New York State Highway Department.

Mr. M. G. Barnes, M. Am. Soc. C. E., Consulting Engineer, member of the Board of Consulting Engineers for the improvement of the New York State canals, announces that he has taken into partnership Mr. Walter M. Smith, M. Am. Soc. C. E., for the past seven years Designing Engineer of the Board of Water Supply, New York City. A general engineering practice will be conducted under the firm name of Barnes & Smith.

Mr. Elmer E. Allbee has resigned as Mechanical Superintendent of the Safety Car Heating & Lighting Co., New York City. Mr. Allbee graduated in civil engineering at the University of Vermont in 1889, and received the degree of Mechanical Engineer there in 1904. He entered the employ of the Safety Car Heating & Lighting Co. in 1890. He was soon promoted to be Mechanical Engineer and for the past 11 years has been Mechanical Superintendent.

Mr. Timothy E. Byrnes has retired as Vice-President of the New York, New Haven & Hartford R.R. and the Boston & Maine R.R. He was born in Bellows Falls, Vt., in 185[illegible] He

studied law at Columbia University and at the University of Minnesota, and for several years practiced law in Minneapolis, Minn. In 1892 he was appointed Special Counsel of the Great Northern Ry. Mr. Byrnes was afterward ade Assistant to the President of the Northern Pacific Ry., in which capacity he remained until 1906, when he was elected Vice-President of the New York, New Haven & Hartford R.R., under his former Northern Pacific chief, Mr. C. S. Mellen.

Mr. W. B. Saunders, M. Am. Soc. C. E., recently with the field staff of H. M. Byllesby & Co., Chicago, Ill., has opened offices in the Plymouth Bldg., Minneapolis, Minn., for the general practice of civil engineering, specializing in hydraulics and appraisals of public utilities. Mr. Saunders has been in engineering work since 1903, and from 1905 to 1909, inclusive, he was Assistant Engineer of the United States Reclamation Service on several projects in the Northwest. Since 1910 he has been with H. M. Byllesby & Co., engaged in making surveys and reports of properties in the West and South. He was also Resident Engineer on the construction of the Blue Earth dam and power plant near Mankato, Minn., and on the Coon Rapids dam and power plant on the Mississippi River near Minneapolis.

Mr. D. C. Hayne has been appointed First Assistant City Engineer of Indianapolis, Ind., at a salary of $2000 per annum. Mr. Charles A. Brown has been appointed Second Assistant City Engineer, in charge of sewers, at a salary of $1800 per annum. Mr. J. Harry Deane has been reappointed Third Assistant Engineer, in charge of streets, at a salary of $1800 per annum. Other salaries of engineering assistants at Indianapolis are of interest to engineers; there are two transitmen at $1200 per annum; two draftsmen at $1200 and three at $1020 per annum. Rodmen receive $840 a year and the Chief Inspector on construction work $1500. These salaries compare very favorably with those of various city clerical positions. Indianapolis has the reputation of being notable for the low cost of living—due, doubtless, to being situated in the heart of a great agricultural district.

Mr. Frederic B. Lincoln, recently Assistant to the Receiver of the Pittsburgh, Shawmut & Northern R.R., and former Superintendent of Construction for the O'Rourke Engineering Construction Co. on the Grand Central Terminal work, New York City, has been appointed General Superintendent of the Erie grand division of the Erie R.R., with headquarters at New York City. Mr. Lincoln's railway experience began in the engineering department of the Erie R.R., in 1887, as a rodman. He was subsequently promoted to be a transitman and in 1890 to be Assistant Engineer of the Allegheny and Susquehanna divisions. Later he was Trainmaster, Agent and Division Superintendent. For two years following 1904 he was Trainmaster and Division Superintendent of the Delaware & Hudson R.R., after which he returned to engineering work as Superintendent of Construction of the Delaware & Eastern R.R.

Mr. J. M. Davis, whose resignation as General Superintendent of the Southern Pacific Ry., at San Francisco, Calif., was noted in our issue of Dec. 25, 1913, has been appointed Assistant General Manager of the Baltimore & Ohio Southwestern and the Cincinnati, Hamilton & Dayton Rys., with headquarters at Cincinnati, Ohio. Mr. Davis began railway work as a freight brakeman and later served in various clerical capacities on railways in the Southwest and Mexico until 1895, when he went to the Great Northern Ry. at Duluth, Minn., as a clerk in the General Manager's office. He was promoted to be Division Superintendent and later served in the same capacity on the Erie R.R. at Scranton, Penn. In 1903 Mr. Davis returned to the Great Northern Ry., where he was soon promoted to be Assistant General Superintendent. He joined the operating department of the Harriman lines in 1905 as Assistant General Superintendent at Salt Lake City, Utah.

Mr. James Burke, Superintendent of Roadway, Bridges and Buildings of the Erie R.R., at Cleveland, Ohio, has been promoted to be Superintendent of the Chicago terminal division, at Chicago, Ill. Mr. Burke is a native of Oswego, N. Y., and began railway work at the age of 17 years with the engineering corps of the Chicago, Milwaukee & St. Paul Ry., in 1873. Later he was with the engineering corps of the Chicago & Northwestern Ry. In 1880 he accepted a position as a work-train conductor on the Atchison, Topeka & Santa Fé Ry., and in a short time was promoted to be Assistant Roadmaster. For three years, 1883 to 1886, he was Division Roadmaster of the Minneapolis & St. Louis Ry., and for the 12 years following Division Roadmaster, Superintendent of Construction and General Roadmaster of the Minneapolis, St. Paul & Sault Ste. Marie Ry. He was Division Engineer of the Baltimore & Ohio R.R. from 1899 to 1902; since then he has been with the Erie R.R. as Engineer of Maintenance-of-way and Superintendent of Roadway, Bridges and Buildings.

Mr. William A. Shaw, Civil Engineer, President of the American Engineering & Construction Co., of Chicago, Ill., has been appointed a member of the new Public Utilities Commission of Illinois. Mr. Shaw was born at Mt. Morris, Ill., in 1866; he graduated in civil engineering from Valparaiso University in Indiana in 1891. After graduation he was first employed in the City Engineer's office at Rockford, Ill. Later he was City Engineer of Rogers Park, a suburb of Chicago, Ill., which was annexed to the city in 1893. For a couple of years he was Division Engineer in the sewer department of Chicago, leaving the city employ in 1895 to enter private practice, specializing in municipal work. In 1898 he returned to the Chicago sewer department where for several years he was in charge of much important construction work, serving a part of the time as Chief of the intercepting sewer division. In 1905 he was made Engineer in charge of the Chicago water-works, resigning in June, 1907, to become President of the American Engineering & Construction Co., which has had some large sewer contracts for Louisville, Ky., Chicago, and other cities. Last summer he was appointed a member of the Illinois Rivers and Lakes Commission.

Mr. Joseph Wood, First Vice-President of the Pennsylvania R.R. lines west of Pittsburgh and President of the Vandalia R.R. and other subsidiary lines, has resigned, effective, Feb. 1. Mr. Wood is another of the civil-engineer executives of the Pennsylvania R.R. He graduated in civil engineering from the Pennsylvania Polytechnic College in 1864, and in the autumn of the same year entered engineering work as a rodman on the construction of a connecting railway at Philadelphia, Penn. He was soon promoted to be Assistant Engineer, and in 1869 was appointed Resident Engineer of the Northern Central Ry. In May, 1872, he became Resident Engineer of the Baltimore & Potomac R.R. and Engineer of the Northern Central Ry. In 1878 after 14 years in civil-engineering work, Mr. Wood accepted a position in the mechanical department of the Pennsylvania R.R. as Assistant to the Superintendent of Motive Power, at Altoona. In 1881 he was made Superintendent of Motive Power of the Pennsylvania Co., and six years later he was promoted to be General Superintendent of Transportation of this and subsidiary companies. In March, 1890, Mr. Wood became General Manager of the Pennsylvania R.R. lines west of Pittsburgh; in 1896, he was elected Fourth Vice-President, and in 1905 First Vice-President.

Mr. A. S Zinn, M. Am. Soc. C. E., has resigned as Resident Engineer, of the Fourth division of the Panama Canal, and the position has been abolished, the dry excavation work having been entirely completed. Mr. Zinn was one of the earliest American engineers to go to the Isthmus; in the reorganization of the engineering forces in 1907 he was appointed Resident Engineer of the Central division under the late Lieut.-Col. Gaillard, Division Engineer, and has since been continuously in charge of much important work in this most troublesome section of the canal. The reduction of the engineering forces of the Fourth division is the natural consequence of the decreased steam-shovel work. At the time the Central division was abolished, Oct. 10 last, and the Fourth division created, it was expected to keep at least 12 steam shovels busy for an indefinite time on the work of excavating at the tops of the Culebra cut slides to lessen the weight of the moving material; but a change of plan has been made, following the good showing made by the dredges at work in the cut, and the relatively slight movement of the slides, and all the steam shovels have now been removed from west bank and but four are left on the east bank. Mr. Zinn will spend about two months longer on the Isthmus, and will return to his home in Chicago, Ill., in the spring.

OBITUARY

William D. Marks, M. Am. Inst. E. E., for several years Whitney Professor of dynamic engineering at the University of Pennsylvania, and a well known consulting engineer, died Jan. 6, at the Champlain Valley Hospital, Plattsburg, N. Y. He was born in St. Louis, Mo., on Feb. 26, 1849. At the age of 21 years he was graduated in civil engineering at Sheffield Scientific School, Yale University, where the year following he received the degree of Civil Engineer. He was engaged in engineering work on various railways, gas-works and iron-works until 1876, when he was appointed Instructor in mechanical engineering at Lehigh University. The following year he went to the University of Pennsylvania as Professor

of dynamic engineering. In 1887 he was made Engineer and President of the Edison Electric Light Co., of Philadelphia. Prof. Marks was an honorary life member of the Franklin Institute of Philadelphia and a member of the American Philosophical Society. He was the author of several books, reports and scientific papers. In recent years he had maintained an office in New York City.

Herman Charles Meinholtz, M. Am. Soc. M. E., Vice-President and Superintendent of the Heine Safety Boiler Co., St. Louis, Mo., died at his home in that city, Dec. 24, 1913. He was born in St. Louis in 1868. He attended the public schools until 1886, when he was graduated from the Manual Training School. For a few months he was an assistant in the laboratory of Washington University, St. Louis, under the late Prof. J. B. Johnson, but shortly afterward entered the employ of the Heine Safety Boiler Co. as a draftsman. At the beginning of Mr. Meinholtz's connection with the company it was still in its infancy, and he grew up with the business, being promoted successively through various positions until in 1895 he was made Superintendent. In 1907 he was elected Vice-President. It is said of him that, although of a very modest and unassuming disposition he made many friends and was a keen observer and judge of men. He was honest and courageous, and while slow to form decided opinions, after having once arrived at a conclusion, he is said to have very persistently maintained it, and that his judgment was usually justified by the results. Mr. Meinholtz is survived by a widow and five children.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 16. Annual convention in New York. Secy., J. R. Wemlinger, 13 Park Row, New York City.

KANSAS ENGINEERING SOCIETY.
Jan. 20-21. Annual meeting at Lawrence, Kan. Secy., T. J. Strickler, Topeka, Kan.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 20-22. Tenth annual convention at New Orleans, La. Secy., F. J. Angier, Timber Preservation Co., Baltimore, Md.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 21 Annual meeting in New York. Secy., Chas. W. Hunt, 220 W. 57th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 21-23. Annual meeting in New York. Secy., E. A. Scott, 29 W. 39th St., New York City.

INDIANA ENGINEERING ASSOCIATION.
Jan. 22-24. Annual meeting at Indianapolis, Ind. Secy., Charles Brossmann.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 27-29. Annual meeting in Montreal, Que. Secy., Prof. C. H. McLeod, 176 Mansfield St., Montreal, Que.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 28-30. Annual meeting at Peoria, Ill. Secy., E. E. R. Tratman, 1144 Monadnock Block, Chicago, Ill.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Jan. 29-31. Midyear meeting in New York. Secy., E. B. Burritt, 29 W. 39th St., New York City.

NATIONAL LIME MANUFACTURERS' ASSOCIATION.
Feb. 4-5. Annual meeting at New York. Secy., Fred K. Irvine, Chicago, Ill.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 10-11. Annual meeting at Hartford, Conn. Secy., J. Frederick Jackson, Box 1304, New Haven, Conn.

OHIO ENGINEERING SOCIETY.
Feb. 11-14. Annual meeting at Columbus, Ohio. Secy., D. W. Seitz, Columbus, Ohio.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 12-14. Meeting at Chicago, Ill. Secy., J. P. Beck, 72 W. Adams St., Chicago, Ill.

NORTH DAKOTA SOCIETY OF ENGINEERS.
Feb. 12-13. Annual convention at Fargo, N. D. Secy., E. F. Chandler, University of North Dakota, Fargo.

AMERICAN CONCRETE INSTITUTE.
Feb. 16-20. Annual meeting in Chicago, Ill. Secy., E. E. Krauss, Harrison Building, Philadelphia.

IOWA ENGINEERING SOCIETY.
Feb. 18-20. Annual meeting at Council Bluffs, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

MINNESOTA ENGINEERS' AND SURVEYORS' SOCIETY.
Feb. 24-25. Annual meeting at St. Paul, Minn. President, Wm. Danforth, 411 Hackney Building, St. Paul, Minn.

INDIANA SANITARY AND WATER SUPPLY ASSOCIATION.
Feb. 26-27. Annual meeting at Indianapolis, Ind. Secy., Dr. W. F. King, Indianapolis.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 17-20 Annual convention at Chicago. Secy., E. H. Fritch, 900 S. Michigan Ave., Chicago, Ill.

Brooklyn Engineers' Club—At the annual dinner held at the Club, on Dec. 18, Charles S. Doron, A. M. Am. Soc. C. E., was awarded the Alfred T. White prize of $50 in gold and a certificate for the most valuable engineering paper presented before the Club during the past year. His paper was "The Shore Road Improvement of the Department of Parks, Brooklyn." The officers elected for the ensuing year were: President, Edwin J. Fort, Secretary, Joseph Strachan, 117 Remsen St., Brooklyn, N. Y.

Engineers' Club of St. Louis—The annual dinner was held at the City Club on Dec. 17. The election of officers for 1914 was announced as follows: President, A. P. Greenfield; Secretary, W. W. Horner.

National Fire Protection Association—A Chicago Chapter of this Association was organized on Dec. 15, 1913, with a membership of about 200. The Association comprises active and associate members who, as associations and individuals are interested in the reduction of loss by fire. The President is Frank D. Chase, M. Am. Soc. C. E., of Chicago; the Secretary-Treasurer is Wm. S. Boyd, 76 W. Monroe St., Chicago, Ill.

Engineers Society of Western Pennsylvania—The annual meeting of the Structural Section was held at the Society rooms in Pittsburgh on Jan. 6. The subject of the evening, "The Strength of Equipment for Handling Loads," was subdivided as follows: Hooks, Rings, Chains, Cables, Sheaves, Derricks, Cranes and Travelers. The annual meeting of this Society will be held on Jan. 20. President Samuel A. Taylor will present as his retiring address "The Evolution of Bituminous Coal Mining During Four Decades." The Secretary of the Society is Elmer K. Hiles, 2511 Oliver Bldg., Pittsburgh, Penn.

Western Society of Engineers—The annual meeting and dinner were held at the La Salle Hotel, Chicago, Jan. 7, with an exceptionally large attendance. Dr. Edwin H. Lewis, of Lewis Institute, acted as toastmaster, and the principal feature was an address on "Public Service Corporations and Public Utility Commissions," by Prof. Mortimer E. Cooley, Dean of the Department of Engineering at the University of Michigan. Addresses were made also by Mr. Reichmann, the retiring president, Mr. Lee, the incoming president, and S. E. Kiser.

The report of the secretary showed a total membership of 1248 (781 members, 238 associate members, 153 junior members and 76 of other classes). The number of new members was 116, but the net increase in membership was 85. There were five losses by death: J. W. Crissey, M. H. Dance, James W. Johnson, Oscar Sanne and R. B. Seymour. The "Journal," published monthly (except July and August), aggregated 1026 pages of reading matter. The report of the treasurer may be summarized as follows:

Receipts (including bank balance $481)	$19,530
Expenditures	18,584
Cash balance, Dec. 31, 1913	946
Total cash resources (bank balance and investments)	$14,446

The report of the committee on the award of the Chanute Medal for papers presented to the Society during 1913, made the awards as follows: Onward Bates, "Arbitration"; Daniel W. Mead, "The Cause of Floods and the Factors that Influence their Intensity"; W. L. Abbott, "The Northwest Power Station of the Commonwealth Edison Co."

The officers for 1914 are as follows: President, E. H. Lee, Chief Engineer of the Chicago & Western Indiana R.R.; Vice-presidents, B. E. Grant, Ernest McCullough and G. F. Gebhardt; Treasurer, C. R. Dart; Secretary, J. H. Warder, 1735 Monadnock Block, Chicago.

Southern California Association of Members of the Am. Soc. C. E.—At a meeting on Jan. 5, at the University Club, of Los Angeles, Calif., the following officers were elected for the ensuing year: President, J. B. Lippincott; First vice-President, Capt. C. T. Leeds; Second Vice-President, George S. Binkley; Treasurer, Chas. H. Lee; Secretary, W. K. Barnard. W. M. Thomas then presented a paper on the Thomas system of reinforced-concrete bridges.

Cleveland Engineering Society—At a luncheon of the Society, on Jan. 7, Commissioner W. C. Keough and Secretary E. A. Kline, of the Civil Service Commission, invited the Society to coöperate with the Commission in the preparation of questions and the grading of examinations for city engineering positions.

Pacific Northwest Society of Engineers—The officers elected for the ensuing year are as follows: President, Joseph Jacobs; Secy., Jesse A. Jackson, 312 Central Building, Seattle, Wash.

Secretaries of National Technical Societies—A meeting was held in New York, on Dec. 13, to discuss the question of avoiding conflicting dates in the meetings of national scientific and engineering societies. A temporary committee was appointed to report upon this subject and to confer with a similar committee of the Society of Railway Club Secretaries. A joint meeting of these committees is scheduled for Jan. 10.

Engineering Literature

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EDITORIAL COMMENT

The January number of *The Journal of the American Society of Mechanical Engineers* appears with an enlarged page (standard 9x12-in.) and with an enlarged scope and a new arrangement of contents. The reading pages are in four sections. The first and fourth sections are devoted to relatively minor affairs of the Society and to the Engineering Societies Library. The second section contains papers, discussions and reports of meetings of the Society. The third section is a "Foreign Review and Review of Proceedings of Engineering Societies." Different styles of paging facilitate the separate binding of the sections or the rejection of one or more sections. The annual *Transactions* will be discontinued, unless there is a sufficient demand for a special edition in the old 6x9-in. page form. Papers to be presented will be abstracted in the *Journal* in advance of presentation before the Society and will be furnished in full, separately, on receipt of special request.

CORRESPONDENCE

Title-Page Dates

Sir—We have read with much interest the editorial in the Engineering Literature section of "Engineering News," of Dec. 18, 1913, under the caption of "Title-Page Dates."

To eliminate the date from the title page after the original printing would be, in our opinion, detrimental to publisher, purchaser and reader, since the latter, we believe, would view with suspicion a book without such a date. It has been our custom for many years to continue the original edition number on the title pages of our publications until a book has been thoroughly revised or rewritten, thus making it practically a new book, and then to change such edition number and begin again with "First Thousand," or, with "Total Issue, —— Thousand." This plan has always proved satisfactory.

To print on a title page the date of the publication of the first edition would be superfluous, since we believe that buyers and readers of technical books are sufficiently experienced to look at the copyright date to ascertain the original date of issue.

WM. H. WILEY,
President John Wiley & Sons, Inc.

New York City, Dec. 24, 1913.

REVIEWS AND NOTES

Plate-Girder Design

Reviewed by A. W. CARPENTER*

DESIGN OF PLATE GIRDERS—By Lewis E. Moore, Assoc. M. Am. Soc. C. E.; Associate Professor of Structural Engineering, Massachusetts Institute of Technology. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. viii + 285; 82 text illustrations. $3, net.

This book treats of the theory of design of plate girders as applied to American practice, illustrates the practice by examples of specifications and designs and presents tables for facilitating the work. The object of the author appears to have been to cover certain features of design which are either not considered or not satisfactorily discussed in other books on the subject, mainly for the use of students, but with additional material to make it appeal to practitioners as well.

The book is made up of seven chapters of text, one each on Stresses, Rivets, Theory of Plate Girders, Design of a Through Plate Girder, Deck Plate Girder Design, Box Girders, and Shop Hints for Structural Draftsmen, occupying 183 pages in all; a complete reprint of the New York, New Haven and Hartford R.R. Co.'s General Specifications for Steel Railroad Bridges of 1912, filling 18 pages; and 62 pages of tabulated values, diagrams and standards for use in connection with plate girder design.

The subject of stresses is treated very briefly, but perhaps sufficiently, the author sensibly stating that so much has been written on this subject that he held it to "the irreducible minimum."

The author states that he has treated the subject of rivets somewhat more at length and in a different manner from the usual; the reviewer would say that the brief chapter of 8 pages presents very little difference from the usual in text books. There is a good general description of the function of rivets and their formation, so far as power-driven rivets are concerned, but it cannot be commended in giving the impression that all rivets completely fill their holes, as rivets driven by pneumatic hammers or mauls frequently fail grievously in this respect. A brief mention is made of the existence of frictional resistance of riveted surfaces. The usual theory of rivets based on their action as tight-fitting pins is set forth. In referring to the sizes of rivets used in structural work only ⅞ in. ones are mentioned, which seems hardly satisfactory. The reviewer decidedly objects to the author's suggestion that boiler designers' riveted joints are more efficient than those of structural engineers.

Under "Theory of Plate Girders" the so called "approximate" and "exact" methods of designing girder flanges are described very fully. The author attempts to prove the closeness of the two methods by assuming that the usual radius of gyration is nearly equal to half the effective depth and the total area of the girder nearly equal to double the area of one flange. These are very loose assumptions—for the deck girder illustrated in a following chapter the ratios are about 0.86 and 1.36 respectively, (varying according to assumptions as to gross or net section) which are not close approximations. The reason why the two methods approximate the same results would be better explained in showing that the differences, while considerable, are opposite and about balance each other. The author is to be congratulated, however, on pointing out the limitations of the approximate method and the forms of girder sections to which the exact method should be applied.

In treating of the proper distribution of flange area between angles and cover plates the author repeatedly states that the angles should be about one-half the area of the total, but gives nothing convincing in support of this statement. He mentions having knowledge of a case of a girder with wide flange plates and small angles which "failed under loads which it should have supported without difficulty had

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it acted in accordance with the common theory." The author will confer a benefit upon structural designers if he will publish the details of this case, as cases of failure in service of even the most poorly designed and overloaded plate girders, except from lack of bracing, are rare.

The exact formula for shear is compared with the approximate one to show that the latter is nearly correct and safe. In an example the results by the two methods are compared by applying the exact shear to the gross section and the other to the net, which is manifestly misleading. Many cases tested by the reviewer show that the exact method always gives a greater maximum intensity of shear than the approximate one of dividing the total maximum vertical shearing stress by the area of the web, and in cases of certain cross-sections, generally in shallow girders with deep flanges, the excess by the exact method is very great—sometimes as much as 25%.

Considerable space is given to the factors of stiffness and deflection. The reviewer considers the importance of stiffness in free-ended beams for carrying highway or railway loads generally over-estimated and that the author overestimates it for such cases; in cases of beams with restraining end connections to suspenders or columns, the case is one of secondary stresses and more important, especially for the suspenders or columns. About all the stiffener formulas ever proposed are shown and demonstrated—a waste of effort, in the opinion of the reviewer. A set of simple formulas giving the maximum depth of certain beams required for a limiting ratio of deflection to span length, in terms of the length, maximum fiber stress and modulus of elasticity, are new and should be useful within the limits of their applicability. They would be further simplified if the usual values for fiber stress and modulus were substituted for the symbols. They do not apply to beams with variable moment of inertia and do not take account of deflection due to shear, so that their application to built girders with cover plates must be only roughly approximate. The demonstration throws some instructive light on the relation of deflection to position of loads while maintaining a fixed maximum fiber stress. If the deflection of railroad and highway girders were limited by specifying a ratio of deflection to span length instead of one of depth to span length, it would be more rational.

The chapter on "Design of a Through Plate Girder" shows the detail drawing for a 45-ft. railroad through plate-girder span with floor beam and stringer floor, on a lithographed plate and describes the steps in the design in detail. It seems unfortunate that there is no discussion of the factors determining the girder spacing and the number of panels. An even number of panels is shown, which is generally very uneconomical with short girder spans. There is much for the experienced designer to criticize in this chapter, in the reasons given for many points of practice, in the choice of some details and in the treatment of others; and there are a number of discrepancies between the text and the specifications or the illustrative drawing. The treatment of economic depth is unnecessarily vague. The girder web splice appears to be overlooked in the text. In many points, however, the design is quite clearly explained and in accordance with good modern practice.

The chapter on Deck Plate Girder Design covers the design of a 70-ft. railroad deck girder span for timber deck, using the New Haven specifications, and is accompanied by one lithographic reproduction of a drawing showing the detailed design to a very small scale. It is open to the same line of criticism as the chapter on the Through Girder. There is a great deal of fussiness about the end stiffeners and an error in taking the working bearing stress at 16,000 lb. instead of 24,000 lb. which results in some absurdly heavy details.

One criticism of common practice in girder design made by the author appears to be commendable; it is on the common requirement for flange plates to be of equal thickness or to diminish in thickness from the flange angles outward. The author points out that there is no sufficient reason for this and that it is more economical to use a thinner flange plate next to the angles on account of the common requirement that this plate be made the full length of the girder and because splicing of the first plate is facilitated by having the overlying plate of equal or greater thickness. A point which the author does not bring out in this connection is that the thickness of flange plates should be governed by their unspliced lengths and that the ⅜-in minimum is not a sufficient thickness for all lengths of plates to avoid kinking in the shop handling.

The chapter on "Box Girders" applies mostly to architectural practice and illustrates the design of a three-webbed box girder. The chapter is attributed by the author to Prof. W. H. Lawrence of the Massachusetts Institute of Technology. It very clearly explains the exact method of proportioning the flanges and web and spacing the flange rivets, positions diaphragms and stiffeners, but does not include end connections and bearings. While Prof. Moore states in his part of the volume that the angles should form about one-half of the flange section (which statement has already been criticized by the reviewer), Prof. Lawrence designs his box girder with flanges of which the angles form only about 27%. The computations for moment of inertia of gross and net sections are excellently tabulated for practical use and the comparative computations of flange stresses following various assumptions as to gross and net flange sections are illuminating.

The chapter on "Shop Hints for Structural Draftsmen" is by J. C. Moses, Engineer of Construction of the Boston Bridge Works, and is to be commended to all structural designers and draftsmen. It refers to the elements of templet and pattern making, shop work, shipping and erection, that should influence or govern the designer and the shop draftsman in order to obtain the most satisfactory and economical results.

The specifications of the New Haven R.R. (W. H. Moore, Engineer of Bridges), which are reprinted in the book, appear to be based upon and largely identical with those of the American Railway Engineering Association. The form of clearance diagram shown for use in the United States is exceptional and worthy of comment. It provides for 7 ft. 6 in. lateral clearance from the center line of tangent track between points 3 ft. 9 in. and 17 ft. 6 in. above the top of rail, the exceptional feature being the square inset of 1 ft. 4 in. at the 3-ft. 9-in. point. This diagram presents a great advantage over the usual form in connection with the design of girders between tracks, permitting such girders without spreading the tracks in many cases where they could not be used if the diagrams were, as usual, cut off on a sloping line in the lower corner.

The tables seem to cover everything that is needed to enable the designer to properly proportion the principal parts of plate girders without the use of handbooks and with a minimum of computation in case the exact method is followed. They show, for the range of sections ordinarily employed, the areas of web plates; the equivalent web areas for flange section (both one-eighth and one-twelfth); the gross and net areas of angles, with weights; moments of inertia of webs, of double angles spaced at various distances, with percentages for net sections, of pairs of flange plates 10 in. wide spaced variously; stiffener diagrams; rivet shearing and bearing values; nominal overruns on angle legs; rivet standards for heads, clearances in driving and pitch; and multiplication tables for rivet spacing. These tables are worthy of separate publication, in which form they would be most useful in practice.

In general the reviewer finds that this book recognizes much of the most modern thought and practice on its subject and contains much of value to both student and practitioner; he considers the treatment of theory and of methods of practice as frequently unsatisfactory and inaccurate, and that there are too few examples of design for the scope of the subject, especially as regards details. There are also a number of minor inconsistencies and errors, some of which have been pointed out.

⌘

ECONOMICS OF BUSINESS—By Norris A. Brisco, author of "The Economic Policy of Robert Walpole"; Departmental Editor for Canada "Book of Knowledge"; Department of Political Science, College of the City of New York. New York: The Macmillan Co. Cloth; 5x8 in.; pp. xiv + 390. $1.50.

Efficiency in anything is absolutely dependent upon knowledge of the thing, and knowledge begins with definitions. Mr. Brisco, in his book on business, defines the various types of business organizations and the duties of the several officials who manage the affairs of each type. In Chapter IV certain principles of management are laid down which take into account the psychological aspect of labor. This aspect is most important and is not at all obscure or theoretical. In fact, industrial psychology might be renamed with as great truth and greater clarity, "common sense."

In a book of this character, which tries to cover everything in its field, little errors are bound to creep in. On page 69 a statement is made to the effect that "no corporation can be adjudged a voluntary bankrupt." Mr. Brisco's book is dated 1913, and the law which it quotes was amended on June 25, 1910, to allow all corporations, with the exception of municipal, railroad, insurance and banking corporations, to file voluntary petitions in bankruptcy.

The book, as before stated, is very comprehensive and such inaccuracies as the above are easily accounted for, but there is one other criticism which we are constrained to make. The following legend reproduced from p. 115 has a

joyous ring to ambitious youth, but to the ears of experience its tone is hollow: "Many large corporations are under the guidance of men under thirty, who a few years previous started in humble position."

Proper stress is laid upon the necessity for an adequate system of cost accounting. This is followed by chapters on buying, selling, advertising, etc. The book should be valuable to those wishing to have at hand a treatise on general business principles and its plain, nontechnical language makes it especially adapted to the classroom.

Shop and Factory Management

Reviewed by ROSSITER R. POTTER*

PRINCIPLES OF INDUSTRIAL ORGANIZATION—By Dexter S. Kimball, M. Am. M. E., Professor of Machine Design and Construction; Sibley College, Cornell University; author, with John H. Barr, of "Elements of Machine Design," "Industrial Education," etc. New York and London; McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiv + 272; 19 plates and text figures. $2.50 net.

Prof. Kimball's contribution to the literature of scientific management, so called, is based on a course of lectures which he has been giving for a number of years to the senior class in mechanical engineering at Cornell University. He explains in the preface that the book is an endeavor to set before young men entering the industrial field the salient facts regarding the most important modern movements in this field and to explain the origin and growth of the important features of industrial organization.

The first four chapters are chiefly historical, treating of the development of the factory system from the period when skilled artisans owned their own equipment and sold their own product, and on through the industrial revolution of 1770-80 inaugurated by the invention of the spinning jenny, and other textile machinery and by the development of James Watt's steam engine. Prof. Kimball analyzes the character of these inventions and arrives at the conclusion that the fundamental principles involved are (1) the transfer of skill and (2) the transfer of thought or intelligence.

Through the transfer of skill, the accuracy of the work is made to depend not upon the skill of the operator but upon the accuracy of the apparatus. Through the transfer of thought, the machine or apparatus is so made that the unskilled operator can turn out work which, without the machine, would require a much higher degree of intelligence as well as skill. The author cites the modern automatic screw machine as an example of the complete transfer of skill and thought. He states that these principles, transfer of skill and transfer of thought, lie at the bottom of modern industrial methods.

The effects of the industrial revolution upon the worker and upon the industry in general are discussed in the third chapter. By the new conditions, the worker was separated from the tools of industry, and with the invention of new machinery the textile workers of England, for example, were at first degraded since their work could then be done by unskilled and therefore poorly paid operatives. The field of labor, however, was extended in that many unskilled people were enabled to take an important part in the industrial field. Thus while the new methods may degrade certain classes of labor they may also elevate others. At the same time a new field for the skilled mechanic is opened in the making of tools used by relatively unskilled workers. The general effect on industry itself is, of course, to increase production and decrease cost. The author next takes up the corrective influences, such as factory welfare work, industrial legislation, industrial education, etc., looking to the reform of the undesirable conditions which have accompanied the industrial revolution.

Modern industrial tendencies are classified under the headings of aggregation or increase in size, specialization, standardization and interchangeability, division of labor and division of mental labor. The various forms of industrial ownership, such as partnerships, corporations, etc., are next explained.

Then comes the true "scientific-management" part of the book, beginning with a discussion of the general features of industrial administration. It has come to be the accepted order of things that every writer on scientific management must present his list of "principles." Prof. Kimball bows to the law of custom apparently and presents a very modest list of only six principles which "underlie the economic production of manufactured goods." These principles are: (1) Division of labor, including separation of mental and manual labor; (2) and (3) Transfer of skill and transfer of thought; (4) Reduction of unit cost by mass production; (5) Coördination of the work of men and departments; (6) Systematic use of recorded experience. The remainder of this chapter takes up line and staff organization, administrative charts, interpretation of reports, shop conferences and committees, and departmental system.

A chapter on planning departments is chiefly a summary and review of portions of F. W. Taylor's classic paper on "Shop Management." Two following chapters give an excellent review of the principles and methods of cost keeping, analyze depreciation and review the methods of making practical allowance for depreciation in bookkeeping.

Under Compensation of Labor the author explains and discusses the day-work and piece-work systems, the Halsey premium plan and the Rowan modification thereof, the Taylor differential piece rate, Gantt's bonus plan, and the Emerson efficiency plan. Under Prof. Kimball's analysis and comparison, the Emerson plan seems to make the best showing, although the author is careful not to commit himself positively on this point. Chapter XII treats briefly the purchase, storing and inspection of materials and Chapter XIII, the location, arrangement and construction of industrial plants.

The final chapter is a résumé and analysis of theories of management. The author explains that "scientific management" is simply the application of the scientific method to the problems of industrial organization. He states that "scientific management, so called, is not a code of rules as much as it is an attitude of mind that aims to replace, 'I think' with 'I know.'" In this chapter the "principles governing human relations" are added to the six already given as underlying economic manufacture, and the author remarks that personality has been and will remain the great moving force in human affairs. He adds, however, that personality alone is no longer sufficient when called upon to compete with personality backed by classified knowledge.

Prof. Kimball compares the modern "scientific-management" movement with the industrial revolution of 1770. In his final summing up of the situation, he states that while it seems reasonable that the employer should use such scientific data as may be available for increasing production, on the other hand, it must be recognized that the employer can no longer introduce any or all methods into his shop at will. Finally he advances the opinion that the great problem at present is not more economical production but economic and equitable distribution of the fruits of labor.

Others besides "young men entering the industrial field" will read this book with interest and profit. The old-school manager who wishes to get a birdseye view of "scientific-management" methods can find no better book. It is true that anyone wishing thoroughly to study any branch of the subject must refer to works which go into further detail, but on the other hand, no matter how familiar one may be with all the details, he will derive benefit from Prof. Kimball's clear and intelligent review and analysis.

Another Biography of Robert Fulton

ROBERT FULTON, ENGINEER AND ARTIST; HIS LIFE AND WORKS—By H. W. Dickinson, Assoc. M. I. Mech. E., Assistant Keeper, The Science Museum, South Kensington. New York: John Lane Co. London: John Lane, The Bodley Head. Cloth; 6x9 in.; pp. xiv + 333; numerous plates. $3, net.

The author, seemingly, is an enthusiastic and painstaking antiquarian and he has given us the evidences of Fulton's greatness without lavish fulsomeness or harsh condemnation. Some 80 or 90 per cent. of the text must be letters from Fulton or letters about him, some of which have not been given this prominence before, even if they were available. The 10 or 20 per cent. of the text which is in the words of the author is just enough to orient each document historically and establish its contribution to Fulton's life story. This book probably will please more people than any previous biography of this early engineer for it gives the evidence of his actions and leaves each reader to interpret his motives.

If there is any one thing which stands out from a careful reading of these letters, it is that when Fulton jumped from painting into engineering he did not exhibit the technical knowledge which comes only after years of study and experience. But the inevitable crudities, fallacies and ignorance with which a stranger approached engineering very evidently disappear as the years advance. These letters show, too, that Fulton, like all able engineers then and since, secured greater commercial advance by combining all available knowledge of an art than by striving for complete and brilliant originality. These pages seem to disclose an engineer more than an

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"inventor," though Fulton possessed no little practical originality as his development of the art of naval torpedo attack shows.

Fulton has variously been accused of wantonly pilfering the ideas of others, finding in the end somehow that acme of success which was denied them. The letters of his contemporaries here given seem to show that many of the means he employed were known to have been prior piecemeal contributions available to all. Indeed on reading his patent for a steamboat, here given in full as found in the Boulton and Watt papers, it is obviously a patent for his method of designing an operative craft—his scheme of proportioning wheels to hull and engine to wheels, etc. This was a use of data derived largely by others but was nevertheless a great technical advance and a step which was then regarded essentially as invention, no matter how it would be held today when logical procedure in design is the rule rather than the exception.

A Handbook New in Form and Substance

Reviewed by RICHARD A. SMART*

HANDBOOK FOR MACHINE DESIGNERS AND DRAFTSMEN—By Frederick A. Halsey, M. Am. Soc. M. E., Editor Emeritus of "The American Machinist"; author of "Slide Valve Gears," "The Use of the Slide Rule," "Worm and Spiral Gearing," "The Metric Fallacy," etc. New York and London: McGraw-Hill Book Co., Inc. Cloth; 8x11 in.; pp. ix + 494; 700 line drawings. $5 (21 shillings), net.

The reviewer confesses to a weakness for the acquisition of engineering data, especially in handbook form, which is of a piece with the leaning of the youthful reader toward books full of conversation and pictures. And when it is offered in a form which is at once new in conception, pleasing to the eye and well adapted to daily use, the attraction is irresistible.

Mr. Halsey's new handbook answers this description well. Machine designers and draftsmen have been under the necessity of gathering their data for themselves from the technical periodicals, the transactions of the engineering societies and the numerous and excellent treatises on machine design, with occasional reference to the existing handbooks of general engineering information. They can now have at hand for the first time a compilation of data designed for their particular use and taken largely from that mine of information, the files of the "American Machinist." The author says in his Preface that his "heart has often ached at the manner in which contributions to technical journals of permanent value and usefulness form a procession to the limbo of forgotten things and benefit none but those under whose eye they happen to fall at the date of publication. This volume is primarily an effort to rescue from the oblivion of the out of print such contributions as are of direct use in the design of machinery.

It is not, therefore, his intention to present his work in the form of a treatise on machine design, but rather as a reference-data book, designed to supply the specific needs of the designer of machinery in his daily practice.

The author is eminently well fitted to undertake the preparation of such a work, having devoted the best years of his life to the subject, both as a designer and as the editor of the leading periodical devoted to this branch of engineering and having access to a body of information which is not equaled elsewhere.

It may be questioned whether the word "Handbook" has been well chosen as descriptive of a book measuring 9x11¼ in. The English use of the word has reserved it for those compact volumes which are issued in so called pocket size, although these latter often exceed in thickness the dimensions of the average pocket. However, its use in this instance is sanctioned by German practice which does not limit the use of the word to books of any special size. The publishers rightly claim that as the book is for desk use, they are justified in departing from the usual practice of presenting volumes of engineering data in pocket size and have laid out the book in a practical and convenient size for such use and in clear, readable type. The charts, diagrams and tables, of which there are several hundred, are given room enough to be easily read. In fact, while none of the charts are folded, they are of a size suitable to be actually worked upon in making interpolations and the like. In its mechanical construction, the book is in every way worthy of the comprehensive and original character of Mr. Halsey's text.

It is announced by the publishers that it is the intention to keep the book continuously up to date by dropping out the old material as it becomes obsolete and adding such new material as may appear from time to time in the pages of the "American Machinist." This is an excellent plan and it is to be hoped that provision will also be made for including in future editions such new material as may appear originally in other publications.

After a preliminary section dealing in a general way with the mechanical principles of design, in which the author brings out in a clear and pointed manner some of the much neglected principles of the design of machine parts enunciated by Prof. John E. Sweet, the subject of plain or sliding bearings is taken up. This sections deals principally with journal bearings with sliding friction, the characteristics and relations of speed, pressure and temperature for such bearings. The author presents the best and latest information available on these subjects and devotes a generous amount of space to the tables, diagrams and illustrations which supplement his brief but entirely adequate discussion. The sources of information are given in every case for the benefit of those who wish to refer to the original presentation. An invaluable feature of the book, which will appeal strongly to practical designers, is the constant reference to the standard practice of the larger industrial establishments, such as the Westinghouse, General Electric and Baldwin companies. This section also discusses thrust bearings and the use of the Schiele curve.

Other sections give all the important formulas and design data for such things as ball and roller bearings, shafts and keys, belts, pulleys and flywheels, gears, rope and chain drives, brakes, friction clutches, cams, springs, bolts, nuts and screws, pipe and pipe joints, etc. Among the specially notable features of these sections are certain commercial researches in work of roller bearings, certain special designs of large flywheels, studies of Karl Mayer on regulating effect of flywheels, some graphical methods of determining strength and dimensions of gear teeth, Goss' experiments with friction-gear materials, formulas and tables for dimensions and capacities of expanding ring and cone clutches, schemes for layout of cams, a rational method of spring design, Baldwin taper bolts, Kingley's experiments on screw friction, etc., etc.

The section devoted to hydraulics and hydraulic machinery is prefaced by a brief consideration of the theory of the flow of water, but treats the subject largely from the viewpoint of the practicing designer. Attention is given to the design and use of hydraulic fittings and packing. Pipe and Pipe Joints is the title of a section which contains an abstract of the National Tube Co.'s experiments on the bursting and collapsing strength of pipes, tables of the dimensions and strength of pipe and fittings, with a discussion of pipe joints for special service and systems of pipe marking.

An excellent section is that devoted to Press and Running Fits. The author presents in tabular and graphic form the tolerances and allowances recommended and used by the British Engineering Standards Committee, the Lane & Bodley Co., the General Electric, the Westinghouse, the Brown & Sharpe Co., and the C. W. Hunt Co. An interesting diagram shows the stresses in steel and cast-iron hubs when pressed and shrunk on steel shafts.

The section on Balancing Machine Parts takes up the balancing of rotating and reciprocating parts and is followed by Miscellaneous Mechanisms, Constructions and Data, a section containng information relative to a large number of pertinent but unrelated subjects.

The space accorded to the Performance and Power Requirements of Tools exceeds that given to any other one subject. This section will be found invaluable, not only to designers, but to all machine-tool users. The amount of information presented in compact form on the power consumption of machine tools of every description, best feeds and speeds, motor sizes and tool forms is not equaled elsewhere.

Cast Iron, Steel and Alloys are treated in three sections. The first opens with a brief statement relative to the chemistry of cast iron, followed by typical and suggested analyses for use under a great variety of conditions. Over four hundred different analyses are given. The composition and physical properties of steel, representing the most approved practice applying to some fifty different uses, the carbon content in carbon-steel tools, the Navy specification for steel forgings and castings, and a large number of specifications adopted by the Standards Committee of the Society of Automobile Engineers are quoted in the section on steel.

The sections on Steam Boilers, the Steam Engine, the Gas Engine and Compressed Air are not offered as complete treatises on these subjects, but are intended to supply the most important data required by the designer. Much of the material is necessarily not new, but each section contains some new and interesting matter.

Other sections treat briefly of Mechanics, Heat, Strength of Machine Parts, Weights of Materials and Weights and

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Measures. The final section contains a very complete set of mathematical tables of use to the designer.

So little can be found to criticize in this work that the reviewer would be tempted to make his commendation unqualified, were it not for the fact that the publishers have particularly invited suggestions and corrections. The reviewer believes that some rearrangement of sections would be found more logical and convenient. Some material appearing in certain sections could to advantage be transferred to other sections, in order that it could be more readily found. For example, a more suitable place should be found for a paragraph on the properties of india rubber than under the heading of Strength of Machine Parts.

The section heading Plain or Sliding Bearings is apt to be misleading in that it refers almost entirely to bearings having rotary motion whereas common practice makes use of the term sliding bearings when referring to those involving rectilinear motion only. The justification for its use in this case is evidently that it refers to bearings having sliding, as distinguished from rolling, contact.

It would greatly facilitate cross reference if page numbers were added to paragraph headings, some of which are given for cross references that do not appear in the index except in modified wording. For example, on page 58 are the words "See Arms of Spur Gears." There being no such heading to attract the eye in the section on Spur Gears, one must turn to the index to find "Gears, Spur, chart for arms of, 98."

The book is comparatively free from typographical errors and is provided with a good working index.

Graphics and Structural Design

Reviewed by R. FLEMING*

GRAPHICS AND STRUCTURAL DESIGN—By H. D. Hess, M. Am. Soc. M. E., Professor of Machine Design, Sibley College, Cornell University; formerly Designer and Computer for the Mechanical Department of the Pencoyd Iron Works and the American Bridge Co. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. viii + 426; 429 text figures. $3 (12½ shillings), net.

In the preface the author states that the text is intended for his classes in general engineering design and also that the problems chosen for discussion are those on the border line between civil and mechanical engineering. As a textbook, unless supplemented by others, it is inadequate for the equipment of an engineering student in either graphics or structural design. Treating of subjects so varied as conveyor girders, reinforced concrete, and chimneys, the space given to each must necessarily be so limited as to curtail its usefulness as a book of reference.

Chapter I on Materials is largely taken from handbooks; Chapter II on Graphics, III on Stresses in Structures, and IV on Algebraic Determination of Stresses should be enlarged to cover a wider range of examples. Succeeding chapters are on Influence Diagrams, Tension Pieces, Compression Pieces and Beams, Columns and Girders for Conveyors. The reader will be disappointed to find Chapter IX, on Trusses, Bents and Towers, to be but eight pages treating only of bents for carrying overhead pipes about yards, and towers for transmission lines.

Chapter X, of some twenty pages, is given to the Design of a Steel Mill Building. This is a subject in which the reviewer is especially interested and will be examined in detail. In the first place the student will look in vain for the Figs. 152 to 158 to which references are made in the text. In the design of compression pieces the author at times deducts rivet holes and uses net section. Just why he does this, and where he draws the line between using the net and the gross section, is not stated. An unfamiliar formula is given here and elsewhere in the book for the normal wind pressure on a roof. While the resulting normal pressures are close to those obtained by the well known Hutton formula the reviewer prefers Duchemin's formula because it gives results more nearly in accord with the most careful experiments.

The author, in his calculations for roof trusses, uses an equivalent load of 40 lb. per square of horizontal projection rather than a separate determination of truss stresses for dead, snow and live loads. In his specifications (Chapter XXI) he quotes C. C. Schneider as indorsing this practice. A reference to Schneider's "Specifications for Structural Work of Buildings" will show that Mr. Schneider uses the square foot of exposed surface and not the square foot of horizontal projection.

It is noted that a horizontal wind pressure of 20 lb. per sq.ft. is called for in the author's specifications while without any explanation 15 lb. per sq.ft. is used in designing columns. The author assumes the inside angles of the column to transfer the crane load to the full section of the column. A better practice is to have these angles carry the crane load direct to the base. This often necessitates the addition of a cover plate or channel.

A number of clerical errors and inconsistencies are found throughout the chapter: Page 125, 2.65 sq.in. should be 12.65 sq.in.; 5.83 sq.in. should be 15.83 sq.in.; for the area 7.00 sq.in on page 125, 7.3 sq.in. is used on page 126; the addition sign (+8) is given in formula for value M on page 126 when the division sign (÷8) is intended; the area of the column section on page 127 is 13.36 sq.in., while at the middle of page 128 an area of 16.00 sq.in. is used for apparently the same section.

The opening paragraph of the next chapter, on the Design of a Railway Girder, closes with "all rivets will be ⅞ in. in diameter and rivet holes will be reamed to 1 in. in diameter." In actual practice reaming is done, as stated in the author's specifications, "to a finished diameter of not more than ⅛ in. larger than the rivet."

Crane Frames, Girders for Traveling Cranes, Reinforced Concrete, are the subjects of succeeding chapters. But 13 pages are assigned to the difficult subject of foundations—six to foundations for machines, and seven to foundations for buildings. It is observed that in calculating grillage beams the extended part is treated as a cantilever beam carrying a uniform load. The reviewer believes the method of calculation given is radically wrong. The maximum bending moment should be taken at the center of the beam and not at the edge of the base or tier of beams. The column base is seldom strong enough to carry the entire load at its perimeter. When there are two tiers of grillage beams, as shown in the author's diagram, the outer beam of the upper tier is certainly not capable of carrying the projecting load from the lower tier.

Chapters follow on Chimneys, Retaining Walls, Bins, Floors, Walls and Roofs. The formula given for the strength of corrugated roofing is wrong. From the table deduced from this formula which the author gives it will be found that a piece of corrugated steel of No. 20 gage, 2 ft. wide and with a span of 3 ft., can safely carry 354 lb., also that a piece 2 ft. wide with a span of 6 ft. can safely carry 360 lb. Of course this is absurd.

The Specifications for Structural Steel Work, Chapter XXI, are unusually full and complete, and leave little to be desired in this line. Objections will probably be raised to single paragraphs, depending upon the personal equation of the engineer. The reviewer has already called attention to the matter of wind pressure. He would also like to see a clause inserted barring the use of trussed purlins for roofs.

The last chapter, the longest in the book, is a collection of 195 problems, just such as are met in ordinary practice. Such a collection cannot but be of value to the student, whether in or out of college.

The author brings his references throughout to a recent date. The typography of the book is excellent though marred by a number of errors.

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An Automobile Catechism

QUESTIONS AND ANSWERS RELATING TO AUTOBOMILE DESIGN AND CONSTRUCTION, DRIVING AND REPAIR: A Self-Instructor for Students, Mechanics and Motorists—By Victor W. Page, author of "The Modern Gasoline Automobile" and "Location of Gasoline Troubles Made Easy." New York: The Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. 608; 329 illustrations. $1.50.

The excellent treatise on the modern gasoline automobile by the author of this book was reviewed in our Engineering Literature section of Feb. 13, 1913. The present book is a smaller, lower-priced, and more elementary treatment of the same subject presented in catechism form. One of the great needs of the automobile industry today is more accurate technical knowledge by the owners and drivers of automobiles, particularly the drivers of motor trucks. The book before us is an excellent one to place in the hands of any chauffeur or garage repair man. We believe there are few such men, even among those of long experience, who will not find the book a useful aid in their work. While the book is written with the need of the nontechnical user in mind, great pains have been taken to make the work scientifically accurate, and there are very few cases that we have noted where any fault can be found with the accuracy of the author's statements. One of these rare examples occurs on page 356 where the author says: "In a horse-drawn vehicle the weight of the animal between the shafts prevents the conveyance from tipping over even at the very short corner turns."

Special commendation must be given to the illustrations, which are not merely clipped from trade catalogs, as is too

often the case with technical books, but appear in most cases to have been specially made for the work, with a profusion of lettering and arrow marks to make the operation of the device as clear as possible to the reader. It would be difficult to overestimate the influence which the automobile has had in teaching the elements of mechanical engineering science to the general public. Such excellent books as this greatly assist in this educational work.

The Mechanics of Flying Machines

Reviewed by WILLIAM McENTEE*

MECHANISCHE GRUNDLAGEN DES FLUGZEUGBAUES. By A. Baumann, Professor an der Kgl. Techn. Hochschule Stuttgart. Vols. I and II. München and Berlin: R. Oldenbourg. Cloth; 6x9 in.; pp. 154 and 114; 36 and 28 text figures, respectively. 4 Marks per volume.

Following a brief introduction the first volume is divided into five parts. The first part consists of 39 pages dealing with the resistance of air to the movement of solids of simple form, and the second part of 36 pages with the power required to maintain such solid forms in flight. In the third part the complete flying machine is considered as regards resistance and power. The fourth and fifth parts deal with materials of construction and with propellers and motors, respectively, each covering 19 pages.

The second volume is divided into six parts all relating to the completed machine. The subjects of the parts are, in their order: starting flight, landing, steering, motor-upsetting moment, practice flight, and construction details. The 18 plates in the second volume are practically all graphic representations of the more important results of Eiffel's experiments, though some cover work done by Frank and Föppl.

The important and more difficult matter of stability is to be dealt with in a third volume which is to be issued at a later date to complete the present work.

The author purposely limits himself to the use of elementary mathematics in his treatment of the fundamental principles of mechanical flight. As might be expected in a German work, however, mathematics are used more extensively than in some similar English books covering about the same field. The treatment of the subject is clear and in logical sequence.

Many will not agree with the author in his discussion of the air propeller. From considerations of pitch angle and slip angle he arrives at the conclusion that a pitch angle of about 45° is best for efficiency. This would correspond to a pitch ratio of something over three and does not agree with the results obtained by experiments with both water and air propellers which agree in indicating that a pitch ratio of about 1.5 is best.

THE BUREAU OF SUPPLIES of the Department of Water Supply, Gas and Electricity, New York City. A Report by Elihu Cunyngham Church, Secretary of the Department and Chief of the Bureau. Paper; 6x10 in.; pp. 93; illustrated.

More than two years ago Mr. Church was put in charge of the Bureau of Supplies named just above. The report before us outlines Mr. Church's organization of the bureau and at the same time presents the fundamental principles which Mr. Church believes should govern any such bureau. It contains chapters on organization and administration, purchasing, inspection, storage and issue, and records and accounts. A number of organization and other charts are reproduced. A portion of the contents of the report was presented before the American Water Works Association, at Louisville, Ky., in 1912, and reprinted in condensed form in our issue of June 13, 1912, under the title, "The Philosophy of Purchasing Supplies."

STANDARD REGULATIONS FOR MANUFACTURED GAS AND GAS SERVICE—Washington, D. C.: Bureau of Standards. Circular 32. Paper, 7x10 in.; pp. 169.

This bulletin is tangible evidence of the efforts of the Bureau of Standards to be of practical use to the public-utility commissions of the country and to the utilities themselves. The Bureau has aimed to present fair and moderate requirements, realizing that stringent regulations increase the cost burden of consumers. After a preliminary general discussion of specifications governing service, there follows a section discussing inforcement. There are also proposed ordinances and rules, a summary of existing state laws, an outline of manufacturing and distributing methods, and a collection of data about the industry.

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Wireless Telegraphy

HANDBOOK ON WIRELESS TELEGRAPHY: ITS THEORY AND PRACTICE, for the Use of Electrical Engineers, Students and Operators—By James Erskine-Murray, M. Inst. E. E., Consulting Engineer of Wireless Between Canada and Great Britain. Fourth Edition, Revised and Enlarged. New York: D. Appleton & Co. Cloth; 6x9 in.; pp. xvi + 442; 80 illustrations and text figures; $3, net.

WIRELESS TELEGRAPHY. By C. L. Fortescue, Professor of Physics, Royal Naval College, Greenwich, Cambridge, England: University Press. New York: G. P. Putnam's Sons. Cloth; 5x7 in.; pp. vi + 143; 20 illustrations. 40c. net.

PRACTICAL USES OF THE WAVE METER IN WIRELESS TELEGRAPHY. By J. O. Mauborgne, First Lieutenant 24th U. S. Infantry; formerly Instructor, Army Signal School, Fort Leavenworth, Kan. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 74; 42 text figures. $1, net.

It is natural to expect that any treatise on radiation signaling would have to undergo frequent revision to show the actual state of this rapidly advancing art; four editions in seven years ought to establish the concern and industry of the author to keep his book uptodate.

In reviewing the first edition (Nov. 14, 1907) we noted that it was a general technical exposition of the subject, in no sense popular and requiring for intelligent understanding some knowledge of electrical phenomena.

A comparison of this latest edition with the first shows that a majority of the pages have been preserved in their original form. The revision seems to have been in the nature of additions, with a few eliminations to help make room. But this sort of revision is satisfactory in a book, like this, which employs historical treatment so much.

Important additions are seen on magnetic and electrolytic detectors. Changes in the commercial Marconi system are given in substitute and additional pages. The mere mention of deForest's and Poulsen's systems is supplanted by chapters on uniform-current and shock-excited systems (both using undamped, or only slightly damped, wave trains); notable among these are the developed Poulsen, Goldschmidt, Lepel, new Telefunken and Galletti systems.

The old chapter on directive systems is developed into a larger one carrying the title "Antennas"—describing those aërial constructions by which strength of signal impulses is increased in certain useful directions.

New sections on resonance, damping, coupled circuits, etc., have been appended to the older sections on theory of jigs and jiggers. In the first edition a theory of transmission was outlined and now this is supported by the physical studies of Zenneck, Sommerfeld, Austin, Marconi and others. There are, of course, numerous additions to the sections on measurements and adjustments.

The author has made a start toward an expression for the "commercial efficiency" of a signaling system. He discusses such matters as energy efficiency, speed, reliability, regularity, selectivity, etc., but he does not attempt to combine them —yet. Interesting new appendices give the "International Radiotelegraphic Convention for Control of Coast and Ship Stations" and the draft specifications for the British "Imperial Chain" of Marconi stations.

Prof. Fortescue has compressed into small space a very readable treatise on wireless signaling. It is evidently promised that the reader will have a considerable general knowledge of the fundamentals of physics. For instance the author states, without attempt to expound theory, that the upper atmospheric regions are regarded as being "ionized" under the influence of "ultra-violet waves" in sunlight. From that he proceeds to describe the disturbances met with in practical signaling.

In this style, the various phenomena employed in wireless telegraphy are explained, free recourse to analogies being seen. A couple of chapters describe the more important pieces of apparatus used in the leading system. Two more chapters treat of telegraphy between fixed stations or between land and ship stations; finally there are brief sections on aëronautic, naval and military services, history and wireless telephony. There is a well chosen though short bibliography. Considering the size of the volume, it is perhaps surprising to note the amount of information contained in these latter chapters.

The basis of the third book is the reference text of the U. S. A. Signal School; the matter naturally has been revised and amended in being made available for general use. The author first gives the theory of wave meters (small wireless signal sets which disclose directly the wave length of trains received, or which send out trains of desired wave length), and then describes types in use in the Signal Corps. The rest of

the book discloses methods of determining, besides simply wave lengths, the physical characteristics of sending and receiving stations by the use of the wave-meter set.

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Uses of Reinforced Concrete

Reviewed by LEON S. MOISSEIFF*

DER EISENBETONBAU: Ein Leitfaden für Schule und Praxis. Von C. Kersten, Oberingenieur und Oberlehrer a. D. Teil II: Anwendungen im Hoch- und Tiefbau. Seventh edition, revised and enlarged. Berlin: Wilhelm Ernst & Sohn. Cloth; 5x8 in.; pp. xii + 262; 503 text illustrations. 4.40 Marks.

To attain the seventh edition in seven years falls not frequently to the good fortune of an engineering book. Kersten's little book on the uses of reinforced concrete in building and subsurface construction has deservedly achieved this mark of its popularity. In the 250 pages or so of his book, the author describes in a concise manner all kinds of systems of reinforced-concrete construction in use, especially in Germany. The book presents something like a condensed extract from the voluminous "Handbuch fuer Eisenbetonbau." This does not, however, intend to imply that the author has not made his own individual selection or does not express his own opinions. It is in the large number of methods of reinforcing and in the manifold uses reinforced concrete is put to that the little book excels.

In a concise and matter of fact way the author enumerates one after another the uses of reinforced concrete, beginning with floors, walls, stairs, balconies and galleries, cornices, roofs, halls, arches and cupolas for buildings. He then treats of foundations, water-tight sub-cellars, retaining and inclosing walls, canals and conduits, reservoirs and bins, etc. The practical point of view governs the author at all times and he is aided in this by numerous illustrations.

A chapter containing twelve examples of computations for structures of a wide range will refresh the mind of the practitioner who is not too familiar with the theoretical considerations of reinforced-concrete design.

The book is well gotten up and will continue to be a useful guide to concrete construction.

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Some Jigs and Fixtures

Reviewed by ROSSITER R. POTTER†

JIGS AND FIXTURES: A Reference Book Showing Many Types of Jigs and Fixtures in Actual Use and Suggestions for Various Cases—By Fred H. Colvin, M. Am. Soc. M. E., Associate Editor, "American Machinist," and Lucian L. Haas, M. Am. Soc. M. E., Tool Designer. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. vii + 168; 391 text illustrations. $2, net.

In examining this book one looks in vain for any reference to jigs and fixtures for lathe work, and a more careful investigation shows that the book is limited to milling-machine and drill jigs except for a single chapter on the construction and uses of mandrels.

The opening chapter describes a system of jig and tool drawings and tool-room orders. The system described is an elaborate one suitable only for shops where a large volume of jig- and tool-making work is handled. This chapter includes several pages of proposed standards with tabulated dimensions for parts commonly used in jig making.

The second chapter, on the different kinds of jigs, describes very briefly some 20 or 25 drill jigs, each one of which is shown by line drawings. No mention is made of jigs for purposes other than drill-press work and there is no effort to classify the jigs described.

The next five chapters describe different jig parts and details. These are followed by chapters on mechanical and pneumatic milling fixtures respectively. Chapter X, on the uses and advantages of the latch jig, a type used purely for drill-press work, seems to be out of position. The same may be said of Chapter XIV, on machine-vise jaws, which really belongs with the chapters on milling-machine jigs. The intervening chapters take up the design and materials of a large variety of limit gages and other types of gages used in machine-shop work. A chapter on the construction and uses of mandrels concludes the book.

The material included in this volume is well selected and clearly presented, and the book will be of some interest and value to anyone concerned with the design and construction of milling-machine or drill jigs. Improvement could be made by rearrangement of the chapters and by the addition of a chapter or two on typical jigs and fixtures for engine and turret-lathe work.

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The Bureau of Standards Studies of Electrolysis

ELECTROLYSIS IN CONCRETE. By E. B. Rosa, Burton McCollum and O. S. Peters. Washington, D. C.: Bureau of Standards. Technologic Paper 18. Paper; 7x10 in.; pp. 137; illustrated.

ELECTROLYTIC CORROSION OF IRON IN SOILS. By Burton McCollum and K. H. Logan. Washington, D. C.: Bureau of Standards. Technologic Paper 25. Paper; 7x10 in.; pp. 69; illustrated.

The studies on corrosion of iron in concrete of the physicists of the U. S. Bureau of Standards, which have been discussed previously in "Engineering News," are here presented in greater detail. It is not necessary to review again the notable results; it is sufficient to remark that they justify the expectations of what could be done under favorable conditions for persistent and ramified experimentation following a logical plan.

The second bulletin gives the details of studies which we have also briefly noted before. They give new knowledge of the complex phenomena of corrosion of buried iron subject to stray currents, and are of unusual help in combating this insidious destruction of underground structures.

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LEHRBUCH DER TECHNISCHEN PHYSIK—Von Prof. Dr. Hans Lorenz. Vierter Band: Technische Elastizi,tätslehre. München and Berlin: R. Oldenbourg. Paper; 6x9 in.; pp. xxiv + 692; 229 text illustrations. 19 Marks.

Applied mechanics finds an excellent presentation here. Of far more advanced grade (judged mathematically) than the treatments current in American college instruction, the work yet distinguishes itself by an arrangement specially devised for practical utility. The first half of the book deals with stress problems of Applied Mechanics like those familiar to our student days, but treated in much greater analytical thoroughness; e.g., the treatment of buckling is first handled in the ordinary way leading to the simple Euler formula, then one of the chief approximations is omitted and formulas of stricter validity derived, and finally the integration of the exact differential equation is carried out, with results truly applicable to long, thin, spring-blades. Other problems also found in this first part of the book include, for example, the problem of stresses in pipes, not represented in American works.

The second part of the book concerns itself with the theory of elasticity on more narrowly mathematical lines. It is intended for special study by advanced students, rather than as part of the regular instruction.

The author uses a successful method of presentation, progressing in each chapter and each section from the simple to the complex. He gives special explanation of the solution of all differential equations, thus requiring of the reader only the simple knowledge of normal calculus methods.

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THE TESTING OF MATERIALS—Washington, D. C.: Bureau of Standards. Circular 45. Paper; 7x10 in.; pp. 89.

This pamphlet has been prepared in response to numerous and constant inquiries about the work of the Bureau in general testing of various materials of construction. The several lines of work of the Bureau are disclosed and the usual tests are outlined, etc. There are, first, preliminary discussions of classification properties and their determination, measures of quality, specifications for quality, conditions under which the Bureau does testing, etc. The rest of the volume takes up in order metal products, cements and concrete, ceramics, lime, stone, paints, bitumens, inks, paper, textiles, rubber, leather, oils and greases, chemicals, electrical, magnetic, thermal and optical materials, boiler water, instruments, etc. There is finally a schedule of fees charged for such work as the Bureau does.

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HOUSE HEATING FUEL TESTS. By W. H. Meeker and H. W. Wagner. Bulletin 33. Ames, Iowa: Iowa State College of Agriculture and Mechanic Arts. Paper; 6x9 in.; pp. 85; illustrated.

The information in this bulletin, on the utility of certain Iowa fuels for house heating, is of greatest local interest. The importance of such studies for such a state is obvious, after it is realized that a few per cent. economy in statewide coal consumption means over $125,000 saved. Before giving the details of the tests made, the authors summarize their results in popular discussions of fuel costs, conditions of efficient use, attention required and degrees of cleanliness to be expected.

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NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

DIE AUSSTELLUNGEN DER DEUTSCHEN LANDWIRTSCHAFTS-GESELLSCHAFT ZU STRASSBURG IN 1890 UND 1907, und die Entwicklung des landwirtschaftlichen Maschinenwesens—Von Prof. Dr. Carl Luedecke. [Sonderabdruck aus "Zuhlings landwirtschaftliche Beitung"; Heft 19, 1913.] Stuttgart: Eugen Ulmer. Paper, 6x10 in.; pp. 36; illustrated.

BEITRAGE ZUR GESCHICHTE DER TECHNIK UND INDUSTRIE: Jahrbuch des Vereines Deutscher Ingenieure 1912—Herausgegeben von Conrad Matschoss. 4. Band. Berlin: Julius Springer. Paper; 8x11 in.; pp. 357; illustrated. 8 Marks.

DIE BERECHNUNG DER PRESSLUFTPUMPEN IN THEORIE UND PRAXIS—Von Dr. L. Darapsky. [Sonderabdruck aus der Wochenschrift "Dinglers Polytechnisches Journal."] Berlin: Richard Dietze. Paper; 9x12 in.; pp. 32; 38 text figures.

DER BRUECKENBAU: Lehr- und Nachschlagebuch für Studierende und Praktiker—Von M. Strukel, Professor an der Finnländ. Technischen Hochschule in Helsingfors. II Teil. Enthaltend: Bewegliche und Steinerne Brücken. Leipzig: A. Twietmeyer. Paper; 8x11 in.; pp. viii + 237; 330 text figures. 16 Marks.

THE CONTROL OF WATER AS APPLIED TO IRRIGATION, POWER AND TOWN WATER SUPPLY PURPOSES—By Philip A. Morley Parker, Assoc. M. Am. Soc. C. E. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. vii + 1055; 273 text figures. $5, net.

EGYPTIAN IRRIGATION—By Sir W. Willcocks, Formerly Adviser to the Ministry of Public Works, Constantinope; Managing Director of the Daira Sania Company, and Director-General of Reservoir Studies, Egypt, and J. I. Craig, Director Computation Office; Director Meteorological Section, Egyptian Survey Department; now Controller, Department of General Statistics, with an Introduction by Sir Hanbury Brown, formerly Inspector General of Irrigation, Egypt. Two volumes. Third edition. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 7x10 in.; pp. xxxiv + 884; 188 illustrations and 81 folding plates. $15, net, per set.

ENGINE-ROOM CHEMISTRY: A Compend for the Engineer and Engineman—By Augustus H. Gill, Professor of Technical Analysis, Massachusetts Institute of Technology; author of "Gas and Fuel Analysis for Engineers" and "A Short Handbook of Oil Analysis." Second edition, revised and enlarged. [The "Power" Handbooks.] New York and London: McGraw-Hill Book Co., Inc. Cloth; 4x7 in.; pp. x + 211; 47 text figures. $1, net.

DAS ENTWERFEN UND BERECHNEN DER VERBRENNUNGSKRAFTMASCHINEN UND KRAFTGAS-ANLAGEN—Von Hugo Güldner, Maschinenbaudirektor, Vorstand der Güldner-Motoren-Gesellschaft in Aschaffenburg. Third edition, revised and enlarged. Berlin: Julius Springer. Cloth; 8x11 in.; pp. xx + 800; 1282 text figures and 235 tables. 32 Marks.

FARM MOTORS, Steam and Gas Engines, Hydraulic and Electrical Motors, Windmills—By Andrey A. Potter, M. Am. Soc. M. E., Professor of Steam and Gas Engineering, Kansas State Agricultural College. [Agricultural Engineering Series.] New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. ix + 261; 278 text illustrations. $1.50, net.

FINANCIAL STATISTICS OF CITIES HAVING A POPULATION OF OVER 30,000: 1911—Washington, D. C.: Bureau of the Census. Cloth; 9x12 in.; pp. 401.

FIRST ANNUAL INDUSTRIAL DIRECTORY OF NEW YORK STATE, 1912—Compiled and published under the direction of John Williams, Commissioner of Labor. Albany, N. Y.: State Department of Labor. Cloth; 6x9 in.; pp. 562.

DIE GEISTIGEN MITTEL DES TECHNISCHEN FORTSCHRITTES IN DEN VEREINIGTEN STAATEN VON AMERIKA—Von Conrad Matschoff. [Durch Anlagen erweiterter Sonderabdruck aus der Zeitschrift des Vereines deutscher Ingenieure. Jahregang 1913.] Berlin. Paper; 7x10 in.; pp. 63.

INFLAMMABLE LIQUIDS AND THE PRODUCTS THEREOF—Suggested Ordinance Regulating Their Use, Handling, Storage and Sale, Adopted by the National Board of Fire Underwriters, 135 William St., New York City, and the National Fire Protection Association, 87 Milk St., Boston, Mass. Paper; 6x9 in.; pp. 20.

INVESTIGATING AN INDUSTRY: A Scientific Diagnosis of the Diseases of Management—By William Kent, author of "The Mechanical Engineer's Pocket Book" and of "Steam Boiler Economy." With an Introduction by Henry L. Gantt, author of "Work, Wages and Profits." New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xii + 126. $1 (4½ shillings), net.

JAHRESBERICHT 1912 DES KONIGLICHEN MATERIAL-PRUFUNGSAMTES des Technischen Hochschule zu Berlin, in Berlin-Lichterfelde West. Berlin: Julius Springer. Paper; 8x11 in.; pp. 71; illustrated.

THE MANAGEMENT OF PUBLIC ELECTRIC SUPPLY UNDERTAKINGS—By A. Hugh Seabrook, General Manager, St. Marylebone Electric Supply; formerly Engineer and Manager, and subsequently Consulting Engineer, West Ham Electric Supply. London: "The Electrical Times," Ltd. Cloth; 6x10 in.; pp. 192. 7½ shillings, net.

MASSACHUSETTS STATE BOARD OF HEALTH—Forty-fourth Annual Report, 1912. Boston: Mark W. Richardson, M.D., Secretary. Cloth; 6x9 in.; pp. 779.

In addition to a continuation of the classic Lawrence Experiment Station reports on the purification of sewage and water, this volume contains the following reports of particular interest to engineers: Studies of Fish Life and Water Pollution, by H. W. Clark and George O. Adams; A Study of the Efficiency of Certain Methods for the Sanitary Control of Swimming Pools, by H. W. Clark and Stephen DeM. Gage; Effect of Sewage Disposal, 1912; and A Study of the Hygienic Condition of the Air in Textile Mills with Reference to the Influence of Artificial Humidification, by H. W. Clark and Stephen DeM. Gage.

MODERN CITIES; Progress of the Awakening for Their Betterment Here and in Europe—By Horatio M. Pollock and William S. Morgan. New York and London: Funk & Wagnalls Co. Cloth; 5x8 in.; pp. x + 418; illustrated. $1.50, net.

NOTES ON THE PREVENTION OF DUST AND GAS EXPLOSIONS IN COAL MINES—By George S. Rice. Technical Paper 56. Washington, D. C.: Bureau of Mines. Paper; 6x9 in.; pp. 24.

OIL PRODUCTION METHODS—By Paul M. Paine, Assistant Superintendent, Honolulu Cons. Oil Co., and B. K. Stroud, Petroleum Engineer; formerly Superintendent, Monte Cristo Oil & Dev. Co.; Field Superintendent, Universal Oil Co., With a Chapter on Accounting Systems by W. F. and W. B. Sampson, Expert Accountants with Klink, Bean & Co. San Francisco, Calif.: Western Engineering Publishing Co. Cloth; 6x9 in.; pp. 240; 216 text illustrations. $3, postpaid.

A READER OF SCIENTIFIC AND TECHNICAL SPANISH for Colleges and Technical Schools, with Vocabulary and Notes—By Cornelis DeWitt Willcox, Lieutenant Colonel, United States Army; Professor, U. S. Military Academy; Late General Staff Corps, Officer d'Academic, New York: Sturgis & Walton. Cloth; 5x8 in.; pp. 588; 57 text figures. $1.75, net.

SILT IN THE RIO GRANDE—Report by W. W. Follett, Consulting Engineer, International Boundary Commission and Advisory Engineer, Commission for the Equitable Distribution of the Waters of the Rio Grande. Paper; 6x9 in.; pp. 102.

A lengthy abstract of this report appeared in our issue of Jan. 1, 1914, p. 18. Copies may be obtained from the author, Box 108, El Paso, Tex.

SOUTHWESTERN WATER WORKS ASSOCIATION—Proceedings of Convention, May, 1913. Paper; 6x9 in.; pp. 112.

SPECIFICATIONS FOR CONSTRUCTION OF A STANDARD BUILDING—Report of Committee on Fire-resistive Construction, National Fire Protection Association, 87 Milk St., Boston, Mass. [Reprinted with amendments from Proceedings of 1913.] Paper; 6x9 in.; pp. 9.

In formulating a "standard fireproof building" the Association supplies a highly valuable reference standard for the use of architects, owners and engineers. The pamphlet should reach every member of all these classes; it probably will reach most structural engineers and architects and is bound to exert wide influence.

STROMUNGSENERGIE UND MECHANISCHE ARBEIT: Beiträge zur abstrakten Dynamik und ihre Anwendung auf Schiffspropeller, schnellaufende Pumpen und Turbinen, Schiffswiderstand, Schiffssegel, Windturbinen, Trag- und Schlagflügel und Luftwiderstand von Geschossen—Von Paul Wagner. Berlin: Julius Springer. Cloth; 6x9 in.; pp. xi + 252; 151 text illustrations. 10 Marks.

THIRTEENTH CENSUS OF THE UNITED STATES, Taken in 1910: Vol. III, Population—Reports by States, with Statistics for Counties, Cities and Other Civil Divisions—Washington, D. C.: Bureau of the Census. Cloth; 9x12 in.; pp. 1225.

TRANSACTIONS OF THE AMERICAN CERAMIC SOCIETY, Vol. XV, 1913—Columbus, Ohio: Edward Orton, Jr., Secretary. Paper; 6x9 in.; pp. 747; illustrated.

TRAVELING ENGINEERS' ASSOCIATION—Proceedings of Convention, August, 1913. East Buffalo, N. Y.: W. O. Thompson, Secretary, Care of N. Y. C. Car Shops. Leather; 6x9 in.; pp. 371.

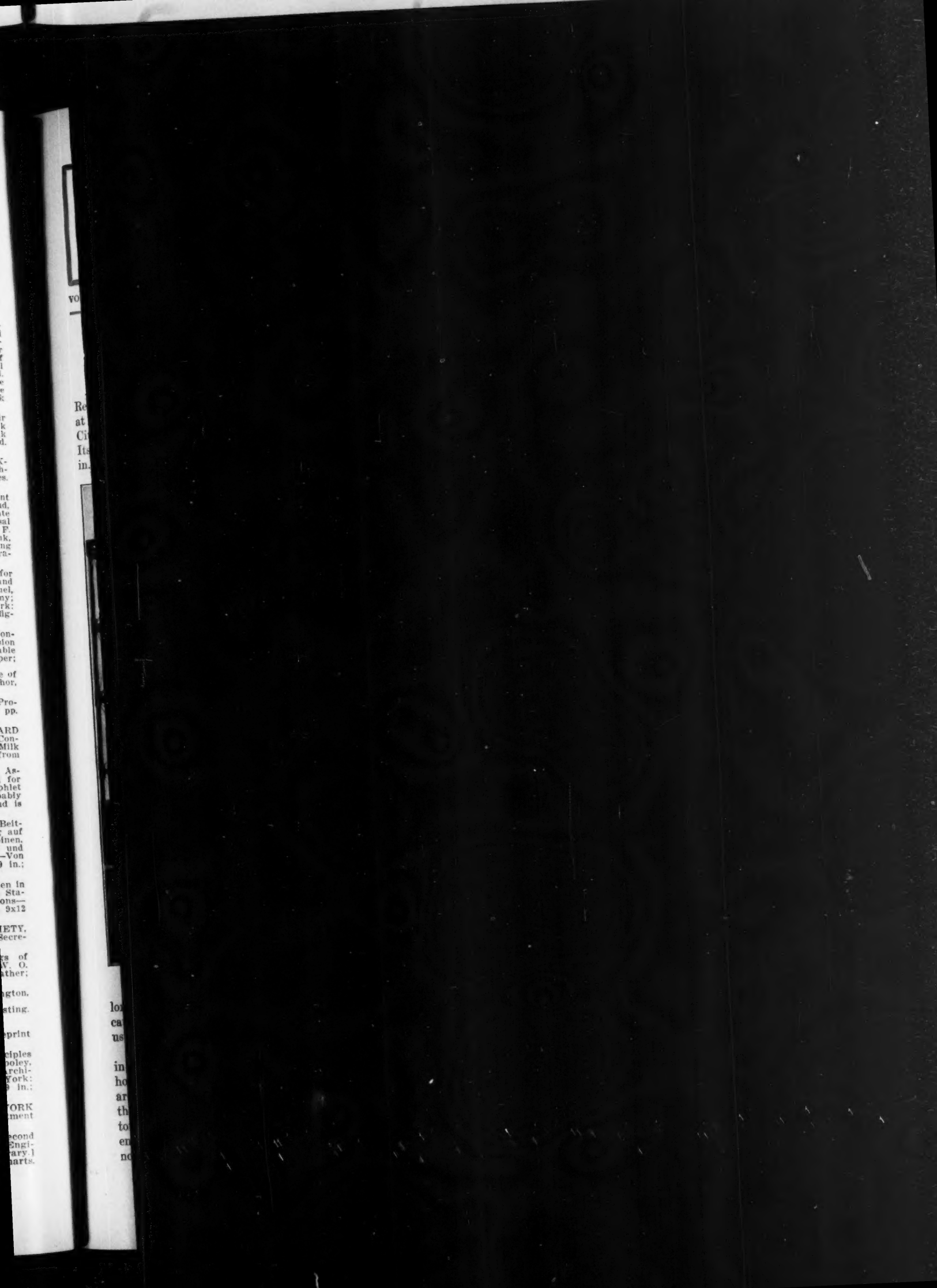
UNITED STATES BUREAU OF STANDARDS—Washington, D. C. Paper; 7x10 in.

Fees for Electric Magnetic and Photometric Testing. Circular 6. Pp. 23.

The Metric Carat. Circular 43. Pp. 12.

High-Frequency Ammeters—By J. H. Dellinger. Reprint 206. Pp. 159; illustrated.

VACUUM CLEANING SYSTEMS: A Treatise on the Principles and Practice of Mechanical Cleaning—By M. S. Cooley, Mechanical Engineer in Office of the Supervising Architect, Treasury Department, Washington, D. C. New York: Heating and Ventilating Magazine Co. Cloth; 6x9 in.; pp. xiv + 244; 105 illustrations. $3, postpaid.

THE WORKMEN'S COMPENSATION LAW OF NEW YORK STATE, 1913—Albany, N. Y.: New York State Department of Labor. Paper; 6x9 in.; pp. 25.

WORK, WAGES AND PROFITS—By H. L. Gantt. Second edition, revised and enlarged. New York: The Engineering Magazine Co. [Works Management Library.] Cloth; 5x8 in.; pp. 313; 27 text figures, 13 folding charts. $2, net.